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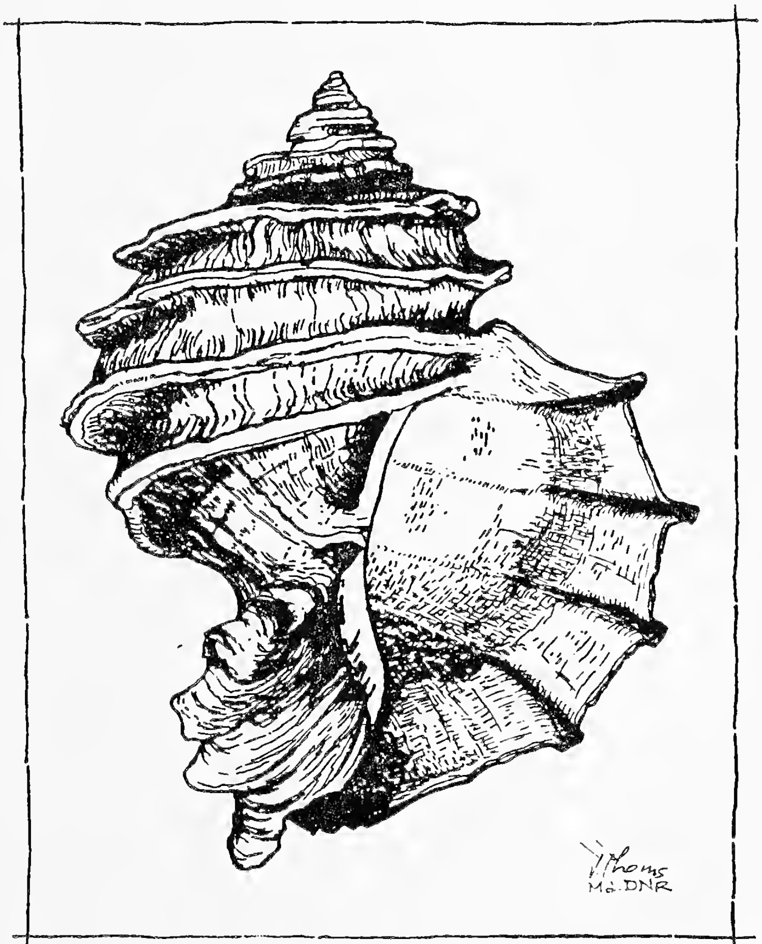
The Maryland Naturalist

THE NATURAL HISTORY SOCIETY OF MARYLAND



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Cover Illustration: Shells of the Genus Ecphora are notable elements of Miocene fossil assemblages on the Atlantic Coastal Plain. Original drawing by Josephine Thoms.

PREFACE

With the pages that lie before you, the Natural History Society of Maryland resumes publication of its journal. Since a hiatus the length of a human generation has occurred in the journal series, it seems appropriate to sketch briefly for the information of present readers some publication history.

The Bulletin of the Natural History Society of Maryland was begun in 1930 when the organization was one year old. It was a four-page mimeographed leaflet, 5-1/2 by 8-1/2 inches, issued monthly. Beginning with Volume 4 the size was changed to 8-1/2 by 11 inches, the number of pages was increased, but the mimeographed format was maintained. The members of the Society themselves carried out the entire production process, including increasing amounts of artwork. Perhaps the high point of this in-house, skilled amateur enterprise was a series of mimeograph illustrations in three colors.

Beginning with Volume 11 each issue received a cover with photographic illustration and the number of issues per year was reduced to 6 and then 5. With Volume 14 the title was changed to Maryland, a Journal of Natural History, it became a quarterly, it was offset printed, and it was provided with numerous photographic illustrations. This format continued, but with Volume 18 the name was again changed, this time to The Maryland Naturalist. During the 1950's financing the journal became increasingly difficult, the issues decreased to one per year, and the series ceased in 1960. The editor throughout the first 28 volumes was the late Herbert Moore; Dr. John Cooper was editor for 29 and 30.

When Arnold Norden in 1985 presented to the Board of Trustees a plan for again publishing a journal of Maryland natural history, it was thought appropriate to revive the title Maryland Naturalist. To emphasize the continuity of the organization, if not of its publication, and on the advice of librarians, the number of volumes is continued from where it left off in 1960, even though the break in dates may cause a slight puzzlement.

Reviviscat liber, revirescamus nos ipsi.

Haven Kolb
Assistant editor, 1940-1960

Some Maryland Mosquitoes Are Extremists

William E. Bickley

Darsie and Ward (1981) presented up-to-date information on the geographical distribution of mosquito species throughout North America north of Mexico, and Ward and Darsie (1982) made additions to that list of distribution records. This note concerns records of the occurrence of mosquito species which seem to have established themselves beyond the expected geographical range.

Maryland is known as a border state. There are plants such as the bald cypress which cannot survive, under natural conditions, north of Maryland or Delaware. Other plants such as tamarack reach their southern limits in Maryland and West Virginia. Some mosquitoes also seem to have reached their extreme limits in Maryland -- north or south.

One of Maryland's rarest northern mosquitoes is Aedes abserratus (Felt and Young). Its known range is from Manitoba to Labrador and from Illinois to New Jersey with an extension southward into Maryland where it has been collected in the Finzel Swamp, Garrett County (Bickley et al., 1971). This species is univoltine (only one generation per year), and is not a serious pest (Carpenter and LaCasse, 1955). In Maryland it is probable that adults do not survive beyond July.

In the eastern U.S. Aedes excrucians (Walker) and Ae. fitchii (Felt and Young) reach their southern limits in Maryland and Delaware. The range of both species extends from Alaska to New Mexico in the West and across the continent to Newfoundland in the East. Ae. excrucians is Holarctic. Ae. aurifer (Coquillett) does not occur as far west and north as do Ae. excrucians and Ae. fitchii, but in the Atlantic coastal region, like them, it reaches its southern limit in Maryland. These three species are univoltine. They overwinter as eggs which hatch early in the spring. Larvae grow in cold water and usually tolerate ice. In many northern localities these mosquitoes are severe pests as the females are extremely blood-thirsty. In Maryland they are not known to be abundant enough to cause much trouble. Ae. fitchii is known to occur in Prince George's and Montgomery Counties; Ae. excrucians occurs in Cecil County; and Ae. aurifer has been collected on the lower Eastern Shore and in Prince George's County.

Aedes dorsalis (Meigen) is a northern and western species. It has not been recorded from the southeastern U.S. although it occurs in Texas west to California. East of Ohio it has not been found south of Maryland. Adults of this species were first found by Mallack (1975) in Allegany County on May 21, 1975. The initial collection was made at Mexico Farms (Cumberland). In later years the late Jerry Mallack and I found adults along the C & O Canal at Mexico Farms, North Branch, and Spring Gap. Collection attempts at Oldtown gave negative results. Dr. Charles W. McComb collected adults upstream from Oldtown (personal communication). None of us found larvae. Presumably we did not start looking for larvae early enough in the spring. There are many temporary and semi-permanent pools along the Potomac which are undoubtedly suitable for Ae.

dorsalis larvae. This is a multivoltine species which is sometimes an important pest in western North America (Carpenter and LaCasse, 1955). Females collected in Maryland are usually larger than females of our more common Aedes spp.

Another large species of Aedes is Ae. fulvus pallens Ross. Adult females are orange-yellow with two prominent dark spots on the scutum. This species occurs in the southern states as far west as Texas. It has not been recorded north of Maryland. Adults have been taken in several counties on the Eastern Shore and in Southern Maryland, but larvae have not been collected. Females bite during the day and are also attracted to light traps.

Culiseta morsitans (Theobald) is a northern mosquito which is distributed from Alaska to Newfoundland with an extension southward into Kentucky. Garrett County, Maryland is a far south as it is known to occur in the eastern U.S. Jerry Mallack and Stanley Joseph first found larvae at the Finzel Swamp in 1970 (Bickley et al., 1971). In 1978 I also collected larvae and adults at the Cranesville Pine Swamp. This Holarctic species is presumed to be a bird feeder (Carpenter and LaCasse, 1955).

Culiseta minnesotae Barr is an uncommon species which is not known to occur south of Queen Anne's County, Maryland where it was first taken in a light trap at Grasonville by Stanley Joseph and Robert Berry in 1967. Later collections are from Rock Hall and Chesapeake City, Cecil County.

Faran and Bailey (1980) collected a single female of Culiseta annulata (Schrank) at Fort McHenry in the Baltimore Harbor, March 8, 1978. This Palearctic mosquito or its ancestors probably came from Europe to Baltimore on a ship. No additional specimens of Cs. annulata have been taken, and Ward and Darsie (1982) stated "...Cs. annulata is not yet an established faunal component."

The discovery of Wyeomyia haynei Dodge in Maryland was reported by Bickley and Mallack (1978). Specimens were taken from a pitcher plant, Sarracenia purpurea L. growing in the Suitland Bog, Prince George's County. This was an unusual finding because it represented an extension northward of the distribution of the species. (It is known to occur in six southeastern states.) The collection of Wy. haynei and Wy. smithii (Coquillett) in the same habitat supports the opinion that they are discrete species. Bradshaw and Lounibos (1977) provided evidence that Wy. haynei is a geographical subspecies of Wy. smithii. Until additional studies are completed it is reasonable to follow the recommendation of Ward and Darsie (1982) that the two names be retained. Larvae of the two species can be distinguished on the basis of the number of anal gills or papillae. The association of Wyeomyia spp. with pitcher plants has been studied extensively, and Smith (1904) has provided much fundamental information. Not only do the larvae of Wy. smithii survive the effects of the chemical content of the water held in the leaves of the plants, they also withstand freezing and thawing.

Recently the "Asian Tiger Mosquito", Aedes albopictus (Skuse) has received publicity in the New York Times and other popular media. A recent paper by Darsie (1986) gives help in identification and references concerning its distribution. Adults of this species resemble Ae. aegypti, the yellow fever mosquito, and larvae may be confused with Ae. triseriatus (Say), our most common tree-hole mosquito. The Asian Tiger Mosquito is believed to have been introduced into Texas and other southern states in used tires brought from the Far

East to the U.S. for the purpose of reclaiming natural rubber. *Ae. albopictus* is an important vector of dengue fever. It can also transmit California encephalitis virus and other viruses. The Morbidity and Mortality Weekly Report for October 1, 1986 gives an update of the spread of the Asian Tiger up the Mississippi Valley and eastward to Georgia. Infestations have been reported in 12 states. Maryland can expect an unwelcome visitor.

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The Butterflies of Rock Creek Park, Washington, D.C.

John H. Fales

Introduction

Rock Creek Park is an urban park located in the District of Columbia, west of 16th Street, N.W. It covers 1,754 acres (710 hectares), and extends from The National Zoological Park northward to the Maryland State Line, a distance of approximately four miles. The width generally is one mile. Rock Creek flows the length of the park and, for a portion of its length, marks the Fall Line dividing the Coastal Plain from the Piedmont Plateau. Mature second-growth forest covers much of the area. Most of the rest of Rock Creek Park is characterized by mowed lawns, although natural meadows have been reestablished at scattered locations. As part of the National Park System, the U.S. Department of the Interior classifies Rock Creek as a "natural" park with a variety of public recreational activities available.

This publication provides an annotated list of the butterflies known from Rock Creek Park, and gives information from published records, specimens in private collections, the U.S. National Museum collection and surveys made by the writer in 1977-1980. Detailed reports describing my surveys for 1977 and 1978 are on file at Park Headquarters, Rock Creek Park. It also provides a list (Table 1) of butterflies recorded from elsewhere within the boundaries of the District of Columbia, which covers 70 sq. miles (180 sq. km). Many of these other species may also occur occasionally within the Park. This report updates in part the work of Clark (1929, 1932), Clark and Clark (1938, 1951), and Wagner (1941a, 1941b) which enumerated all species then known from the District of Columbia and the adjacent areas of Maryland and Virginia. According to those lists, 97 species have been reported from the District of Columbia, and 58 of these have been found in Rock Creek Park. The butterfly classification used follows that of Miller and Brown (1981) and common names follow Opler and Krizek (1984). It should be mentioned that the former open land adjacent to the northern boundary of the park has become a residential area in the last two decades. This no doubt has had an effect on the Park's fauna.

Although the following species accounts include brief descriptions of major identifying characteristics, interested readers are referred to any of the numerous guides that illustrate these beautiful species in full color (Holland, 1931; Howe, 1975; Klots, 1951; Macy and Shepard, 1941; Mitchell and Zim, 1962; Opler and Krizek, 1984). All of these species are also represented in the butterfly collection on display at Rock Creek Park.

Information included herein is extracted from pertinent published studies, label data from the park butterfly collection, and records obtained by me during 45 years of collecting in Rock Creek Park supplemented by data from other collectors.

The Maryland Naturalist 31(1):5-24.

The Butterflies of Rock Creek Park

Discussed below are the 58 species of butterflies known by me to occur in Rock Creek Park, listed by families. Species reported from elsewhere in Washington, D,C. but not yet observed in the Park are identified in Table 1.

Family Hesperiidae (Skippers)

Epargyreus clarus clarus (Cramer)

Silver-spotted Skipper

This larger very common species is dark with tannish squares on the forewings and large white spots on the undersides of the hindwings. It is three-brooded and adults fly from April to October. Park records are from April 30 to September 5. It is attracted to a great variety of flowers. Expanse: 45-54 mm. Larvae are on locust (*Robinia* spp.) and many of its relatives.

Staphylus hayhurstii (W.H. Edwards)

Southern Sooty Wing

This small skipper is mottled-brown with wavy-edged hindwings. It is apparently a recent arrival in the District of Columbia area, first taken by G.O. Krizek near MacArthur Boulevard on August 13, 1972. Wagner (1941b) stated that it "does not occur in the original Washington area." I made the first Rock Creek Park collections at Piney Branch meadow on August 31 and again on September 8, 1977 (Fales, 1978). In 1978 I also collected it at Klingle Mansion on July 29 and August 21, at East Beach Drive on August 8 and at Sherrill Drive meadow on September 12. It was attracted to Porcelain Berry (*Ampelopsis brevipedunculata*). Expanse: 24-30 mm. There are three broods in May, July and September, and adults fly during this entire period. Larvae are found on Lamb's quarters (*Chenopodium album*).

Erynnis juvenalis juvenalis (Fabricius)

Juvenal's Dusky Wing

This common species is brown with darker spotting in both the male and female, but more contrasty in the latter. There are white spots on the forewings, which are larger in the female. There are also rows of imperfect light and dark spots on the hindwings. Most specimens have two prominent light subapical spots on the underside of the hindwings. There is a single brood in the spring. Adults have been found throughout the park from April 7 to June 2. Adults have been collected from blackberry (*Rubus* spp.) buttercup (*Ranunculus* spp.), dandelion (*Taraxacum* spp.), dogwood (*Cornus* spp.) and Red clover (*Trifolium pratense*) as well as sand, gravel and bare ground. Expanse: 35-40 mm. Larvae are on oaks (*Quercus* spp.).

Erynnis horatius (Scudder and Burgess)

Horace's Dusky Wing

This species is very similar to the preceeding but it lacks the two subapical spots on the underside of the hindwing. There are usually two broods, although a third may occur. Adults fly in April, May, July and September. I took this species in the park on May 12 and 15, 1947 and on May 12, 1951. There is also a July 29 record in the park collection, plus a few other undated specimens. Adults have been taken on Alsike clover (Trifolium hybridum), Indian hemp (Apocynum cannabinum), milkweed (Asclepias spp.), Queen Anne's lace (Daucus carota) and sorrel (Oxalis spp.). Expanse: 36-42 mm. Larvae are on oaks.

Erynnis zarucco (Lucas)

Zarucco Dusky Wing

This uncommon species is very dark. There is a light patch before small white spots near the tips of the forewings. There are two broods, April-June and July-September. Two park specimens were taken on garlic (Allium spp.) on July 15. Their expanses were 38 and 39 mm. Larvae are on legumes (Leguminosae).

Pyrgus communis (Grote)

Checkered Skipper

This black and white checkered skipper has three broods, and adults fly from May to October. It was found in the park on September 26 at Piney Branch and Carter Baron meadows. Adults may be found on Red clover. Expanse: 26-33 mm. Larvae are on mallows (Malvaceae).

Pholisora catullus (Fabricius)

Common Sooty Wing

This common brownish-black species is small with a few small white spots on the outer areas of the forewings, above and below. There are two broods. It has been found in the park from June 2 to August 31. Adults have been taken on lespedeza (Lespedeza spp.), milkweed, sorrel and Red clover. Expanse: 23-28 mm. Larvae are on Lamb's quarters.

Nastra lherminier (Latreille)

Swarthy Skipper

This is a small, pale-brown unmarked skipper found in grassy areas. There are two broods, May and August. I captured a single specimen in the park on August 21, 1978 at Klingle Mansion. Clark (1932) did not report this species in the District of Columbia. It is attracted to milkweed. Expanse: 23 mm. Larvae are on grasses (Gramineae).

Ancyloxypha numitor (Fabricius)

Least Skipper

This small skipper has dark forewings and orange hindwings with broad dark margins. It is one of the most common skippers occurring in grassy areas. It has been found feeding on Indian hemp, milkweed and Red clover. There are three broods and park records are from June 1 (T. B. Blevins, personal communication) to October 3. Expanse: 20-25 mm. Larvae are on grasses.

Thymelicus lineola (Ochsenheimer)

European Skipper

This small orange skipper has thin darker wing margins. It has spread southward from the northern states. There is one brood in May and June. I collected two males at Pinney Branch meadow on June 10, 1978, they represented the first published records for the District of Columbia (Fales, 1979a). These individuals were taken on Alsike and Red clover. Expanse: 25 mm. Larvae are on grasses, especially Timothy (*Phleum pratense*).

Polites coras (Cramer)

Peck's Skipper

Both sexes of this brown skipper are predominently marked with yellow, especially on the lower side of the hindwings. The males have black stigmas. This species has three broods and it is very common between May and October. it has been found in park meadows between May 26 and October 21 on Chicory (*Cichorium intybus*), joe-pye-weed (*Eupatorium* spp.), Red clover and thistle (*Cirsium* spp.). Expanse: 23-28 mm. Larvae are on grasses.

Polites themistocles (Latreille)

Tawny-edged Skipper

The male is brownish with prominent stigmas on the forewings, which also have considerable yellow. The female is dark with several square, light spots on the forewings. This species is two-brooded and usually occurs between May and October. In the park, it has been found only on September 5 and 25, 1978 at Sherrill Drive meadow. Adults were on ironweed (*Vernonia*), Red clover and thistle. Expanse: 21-29 mm. Larvae are found on grasses (*Panicum* spp.)

Polites origenes origenes (Fabricius)

Cross Line Skipper

This skipper is very similar to the preceeding species, but is darker and has less yellow. The male stigmas are narrower. There are two broods. Specimens have been taken throughout the park between August 21 and September 25 on aster (*Aster* spp.) and Red clover. Expanse: 25-30 mm. Larvae are on grasses.

Wallengrenia egeremet (Scudder)

Northern Broken Dash

This is a dark species with a few yellow spots. The stigmas on the forewings of the males are divided. The darker females are brown beneath. There are two broods. Specimens have been taken at Sherrill Drive meadow on June 23 and July 15, on aster and Red clover respectively. Expanse: 27-32 mm. Larvae are on grasses.

Pompeius verna (W.H. Edwards)

Little Glassy Wing

Both sexes of this species are dark brown with squarish yellow spots on the forewings, above and below. The male has a narrow black stigma on the forewings. This common skipper has two broods and the adults fly from May to September. Park records are from June 23 to September 5. It is common on clovers, elephant's foot (*Elephantopus* spp.), joe-pye-weed and milkweed. Expanse: 25.5 - 29 mm. Larvae are on grasses.

Atalopedes campestris campestris (Boisduval)

Satchem

The males of this common species have orange wings with dark borders and large black stigmas on the forewings. The femals are darker with orange streaks and white spots on the forewings. Both sexes are yellow beneath. There are three broods and adults occur from May to October. It is scarce in spring. The records for the park are from June 2 to September 25. It is common on Red clover. Expanse: 29-37 mm. Larvae are on Bermuda grass (*Cynodon dactylon*).

Poanes zabulon Boisduval and Leconte

Southern Golden Skipper

The male of this common species is orange above with black borders, and orange below. The female is dark with squarish yellow spots on the upper and lower sides of the forewings. The undersides of the hindwings are purple. There are two broods. This species has occurred throughout the park between May 26 and October 3. Adults have been taken on thistle, Perennial pea (*Lathyrus latifolius*) and Red clover. Park specimens had expanses from 28-35 mm. Larvae are on grasses.

Poanes aaroni aaroni (Skinner)

Aaron's Skipper

This species, similar in appearance to the proceeding, typically frequents saltmarshes. Is known in Rock Creek Park from a single specimen taken in 1903 near the entrance to the National Zoological Park. Ulke (1903) confirmed that marshy conditions existed at that time. When referring to Rock Creek, he stated that the creek "winds its way among mossy sand banks and swamp meadows." It has been taken elsewhere on Indian hemp and milkweed. Adults occur in June and August. Expanse: 27-35 mm. The larval food is unknown.

Family Papilionidae (Swallowtails)

These are the largest butterflies in this area. All have prominent tails on the hindwings.

Battus philenor philenor (Linnaeus)

Pipe Vine Swallowtail

This mostly black species has irridescent bluish-green hindwings above with orange spots beneath. Adults occur from April to October, and there may be three broods. Although not found in recent studies in the park, I have taken this species just to the north. However, D.G. Shappirio (Personal Communication) found it in the park in 1949. Adults have been found on Red clover, wild azalea, honeysuckle, dogbane and thistle. Expanse: 62-94 mm. Larvae are on Pipe vine (Aristolochia).

Eurytides marcellus (Cramer)

Zebra Swallowtail

This black and white striped species is easily recognized by the long narrow tails. There are three broods and adults occur from March until October. This species was not found in the park in recent years, although it was known from this vicinity in the past. D.G. Shappirio (Personal Communication) reported it in the park in 1949. The adults are attracted to numerous flowers, especially Red clover. Expanse: 50-75 mm. Larvae feed on Pawpaw (Asimina triloba).

Papilio polyxenes asterius (Stoll)

Black Swallowtail

This species is black with broken yellow bands on the outer margins of the wings. These bands are more pronounced in the male. There is considerable blue on the hindwings of the female. There are two broods, and adults appear from May to October. Park records are from June 10 to September 18. Adults have been taken on azalea (Rhododendron spp.), honeysuckle (Lonicera spp.), milkweed and Red clover. Expanse: 60-93 mm. Larvae are on carrot and its relatives.

Pterourus glaucus glaucus (Linnaeus)

Tiger Swallowtail

This common, large yellow butterfly with black margins and stripes is probably the best known local species. The females have much blue in the outer portions of the hindwings in both the normal yellow form, and the dimorphic dark form. In the latter, the yellow is replaced by brownish-black. This species is one of the earliest butterflies to appear in the spring. I collected a specimen in the park on April 13, 1945. It sometimes flies as late as October. It is found throughout the park, and there are two overlapping broods. The adults visit many kinds of flowers including azalea, joe-pye-weed, milkweed, Red

clover, and thistle. Park specimens had expanses between 81-112 mm. Larvae are most commonly on wild cherry (_Prunus_ spp.) and Tulip tree (_Liriodendron tulipifera_).

Pterourus troilus troilus (Linnaeus)

Spicebush Swallowtail

Both sexes of this common, large species are black. The males have greenish hindwings above, and the females bluish. There are two broods and adults fly from April to October. T.B. Blevins (Personal Communication) found it here on June 1, 1947. Recent park records are for June, August and September. Adults feed on honeysuckle, milkweed, red clover and thistle. Expanse: 77-97 mm. The principal larval foods are Sassafras (_Sassafras albidum_) and Spicebush (_Lindera benzoin_).

Family Pieridae (Whites and Sulfurs)

These are fairly small, white, orange or yellow butterflies. Several species are quite common in this area.

Pontia protodice (Boisduval and Leconte)

Checkered White

This species occurs irregularly, and it may be absent for several years before appearing again. It is white with squarish black spots, which are darker in the female. It has three broods, and may occur throughout the season. H.U. Clark took a specimen in the park on September 16, 1930 (Clark, 1932). I, however, did not find it in recent surveys. Adults are attracted to asters, clovers and other flowers. Expanse: 35-48 mm. Larvae are found on crucifers (_Cruciferae_).

Artogeia rapae (Linnaeus)

European Cabbage Butterfly

This is the commonest butterfly in this area. The males of this white species have a single black spot on each forewing, while the females have two. It has been recorded throughout the park from March to October. The earliest recent record was April 3, 1984. It feeds on numerous flowers. Park specimens had expanses between 32-44 mm. Larvae are on various crucifers.

Falcapica midea midea (Hubner)

Falcate Orange-tip

This species is smaller than the Cabbage Butterfly. The males have white forewings with orange tips. It is single-brooded, and the adults fly only from late March to early May. It is usually common during that period. Clark (1932) mentioned that Ernest Shoemaker collected this species in the park in April and May. A more recent record was April 24, 1980 at Boundary Bridge. Other local records are from March 30 to May 6. Expanse: 32-41 mm. The larvae are on cress (_Cruciferae_).

Colias philodice philodice (Godart)

Clouded Sulfur

This species, and the next, are nearly as common as the European cabbage butterfly. Its wings are yellow with black borders, which are wider in the females. There is also a dimorphic female form which is white. There are three broods. Recent park records were from April 18 to October 21. Park specimens measured 42-49 mm. in expanse. Larvae feed on Alfalfa (Medicago sativa), clovers, vetch (Leguminosae) and related plants.

Colias eurytheme (Boisduval)

Orange Sulfur

This common species is also known as the Orange sulfur. It is similar to the Clouded sulfur, except that the yellow is replaced by orange. There is also a white female form in this species. The biology is similar to that of the Clouded sulfur, with which it is known to hybridize. There are three broods. Recent park records were from April 7 to October 21. It is one of the earliest butterflies to fly in the spring. The adults visit numerous flowers. Park specimens had expanses between 45-54 mm.

Pyrisitia lisa lisa (Boisduval and Leconte)

Little Sulfur

This is the smallest of the local Sulfur butterflies. Its wings are lemon yellow with narrow black borders, which are less complete in the female. Although it varies in abundance from year to year, it may be present from May to October. The only recent park record was a female taken on September 8, 1977 at Military Field. Its expanse was 34 mm. Although adults have usually been taken in flight, they may be collected on Bidens spp. and goldenrod (Solidago spp.). There are possibly three broods, and larvae are on clovers and Partridge pea (Cassia fasciculata).

Abaeis nicippe (Cramer)

Sleepy Orange

This species is orange with black wing margins, and it can be mistaken for the Orange Sulfur. It is rare in the District of Columbia. I collected the only specimen known from the park at Military Field on August 31, 1977. The expanse was 49 mm. Larvae are on various legumes.

Family Lycaenidae (Blues, Coppers and Hairstreaks)

These are all small butterflies. Some are very colorful, usually on the under surfaces of the wings. The Hairstreaks have small hair-like tails on the hindwings.

Feniseca tarquinius tarquinius (Fabricius)

Harvester

This species is mostly black with orange markings of various shapes. There may be five or more broods from April to October. Wagner (1941a) reported it as common on June 11, 1939 at Morningside Drive near North Portal. I also collected it in the East Beach Drive area on July 25, 1943. It was not found in recent surveys. It occurs along streams where alders grow. Expanse: 25-35 mm. The caterpillars are unusual since they are carniverous, feeding upon aphids on alders (*Alnus* spp.).

Lycaena phlaeas americana (Harris)

American Copper

The forewings of this butterfly are orange with black borders and black spots inwardly. The hindwings are dark with an orange border. It is lighter below. It appears from April to October, and there are four broods. Clark (1932) collected it in the park prior to 1932. It was not seen in recent surveys. Local adults have been collected on Alsike clover, Indian hemp, goldenrod, and on bare ground. Expanse: 23-30 mm. Larvae are on sorrel and dock (*Rumex* spp.).

Satyrium edwardsii (Grote and Robinson)

Edwards' Hairstreak

This rare butterfly is brown on the upper wings. The two rows of spots beneath the hindwings are broken into white-rounded spots, and there are red and blue spots at the tails. There is only one brood, and adults appear in late June and July. I collected single specimens in the park on June 23 and 30, 1978 at the Sherrill Drive meadow; apparently the first records of this species in the District of Columbia (Fales, 1979b). The expanses were 26 and 28 mm. respectively. Larvae are on oaks.

Satyrium calanus falacer (Godart)

Banded Hairstreak

This less-common butterfly is similar in appearance to the preceeding species, except that it is lighter beneath. Also, the rows of spots on the wings are continous, and not rounded. It is single-brooded, and adults fly in June and July. I collected this species in the Park at Sherrill Drive meadow on June 30, 1978. It was also taken earlier at the North Portal area by Wagner (1941a). Expanse: 28 mm. Larvae are on oaks and hickories (*Carya* spp.).

Calycopis cecrops (Fabricius)

Red-banded Hairstreak

This species is mostly brownish above, with some blue on the hindwings. The lower surfaces are lighter, and an irregular band of red bordered with white on the outer edges crosses both wings. There are also black spots on the hindwings

near the tails. It has three broods, and flies from May to October. I took this species at the Park Road meadow on August 8, 1978. This was the first record in Rock Creek Park (Fales 1979b). It was found there again on August 21, 29 and September 5 of that year. Although adults usually rest on the leaves of various shrubs and trees, specimens were taken on goldenrod, Porcelain berry and smartweed (Polygonum spp.). Expanse: 23-27.5 mm. Larvae feed on sumac (Rhus spp.).

Mitoura gryneus gryneus (Hubner)

Olive Hairstreak

The upper wing surfaces of this butterfly are yellowish with dark margins. The under surfaces are green with a white line on the forewings, and irregular white and brown lines on the hindwings. There are two broods, April-May and June-July. D.G. Shappirio (Personal communication) collected a specimen at North Portal on June 2, 1947. Adults are usually observed around Red cedar (Juniperus virginiana). Expanse: 23-28 mm. Larvae are on Red cedar.

Incisalia henrici henrici (Grote and Robinson)

Henry's Elfin

The upper surfaces of the wings of this species are brownish, but brighter near the edges. They are brown beneath, and much darker inwardly. There is one brood, and the adults fly from late March until May. They visit blueberry (Vaccinium spp.) and redbud (Cercis canadensis). Specimens have been taken at the north end of the park at 16th Street and the District Line on March 30, 1935 (Wagner, 1941a). Expanse: 25-27 mm. Larvae are on blueberry.

Incisalia niphon niphon (Hubner)

Pine Elfin

The upper wing surfaces of this species are dark brown in the males, but brighter in the females. The hindwings below are irregularly marked with dark and light brown lines. The wings have white edges. There is one brood, and the adults appear from April to June. It was not seen in the park in recent surveys, but Clark (1932) reported it there in the month of May. Adults have been taken on blueberry, Chinquapin (Castanea pumila), White clover, pines (Pines spp.), and often on the ground. Expanse: 25-29 mm. Larvae are on pine.

Strymon melinus humuli (Harris)

Gray Hairstreak

This common species is gray with red and black spots on both surfaces of the hindwings, near the tails. It is reported to have four broods between April and October. It has occurred throughout the park from June to September, but was not abundant in recent studies. It was found here on Porcelain berry and goldenrod. Expanse: 23-30 mm. Unlike most butterflies, the larvae are on

various plants, but especially composites, legumes, mallow, mint (*Mentha* spp.), Persimmon (*Diospyros virginiana*) and members of the rose family (Rosaceae).

Everes comyntas comyntas (Godart)

Eastern Tailed Blue

This common species is the smallest butterfly in this area. The males are blue and have wings with a thin dark border. The females are brownish-black and sometimes they have blue scales. There are two orange and black spots at the tails on the hindwings. Both sexes are lighter beneath with black spotting. In recent studies this species was the third most common species found, and ranged throughout the park from April 18 to October 21. There are three broods. The adults are attracted to many flowers including Alsike clover, Red clover, asters, dandelion and milkweed. The expanses of park specimens were 18-26 mm. Larvae are on various legumes.

Celastrina ladon ladon (Cramer)

Spring Azure

This common species is usually the first butterfly seen in the spring. it is larger than the preceeding species. The wings are light blue in both sexes; and the females have black borders. There are dark spots on the under surfaces, and tails are lacking. It flies from late March into September, and there are three broods. Park records are from March 29 at Boundary Bridge and Equitation Field to September 19 at Sherrill Drive meadow. Adults have been found on dogwood, honeysuckle, Porcelain berry and Red clover. Park specimens had expanses of 26-28 mm. Larvae are on many plants including blueberry, dogwood, sumac and Arrow-wood (*Viburnum*).

Family Libytheidae (Snout Butterflies)

Libytheana bachmanii bachmanii (Kirtland)

Eastern Snout Butterfly

The wings of this species are orange with broad dark borders and white spots on the outer forewings. The hindwings are brownish below. There is also a beak-like projection on the head. There are three broods, and adults occur from June to October. The only park record was by the author on August 8, 1978 at Military Field. The expanses of local area specimens were 39-46 mm. Larvae are on hackberry (*Celtis* spp.).

Family Nymphalidae (Brush-footed Butterflies)

This family contains many species, most of which are larger butterflies. They are also known as Four-footed Butterflies.

Euptoieta claudia (Cramer)

Variegated Fritillary

This medium-sized butterfly has wings of several shades of light brown with black markings and spots. It is brighter colored below. Three broods follow the occurrence of overwintering adults in May. Local records are from June 2 to November 4. A specimen was collected on August 20, 1947 by the writer at the northern area of the park. Clark (1932) reported it in this same area, and also along Rock Creek near the National Zoological Park. It was not recorded in recent studies. Adults are attracted to many flowers including aster (Bidens spp.) goldenrod and Red clover. Expanses vary greatly, from 41-70 mm. Larval host plants include May-apple (Podophyllum peltatum), Purslane (Portulaca oleracea) and violets (Viola spp.).

Speyeria cybele cybele (Fabricius)

Great Spangled Fritillary

The wings of this large butterfly are dark brown inwardly, and lighter red-brown outwardly. They are marked with irregular black bars, spots and bands. The hindwings below are chocolate-brown with a buff outer band, and there are also numerous large silver spots. It is said to have one brood, which is spread out from May to October. Some local area and Rock Creek Park records are June 13, 15, 16, 23; July 21; August 20, 31; and October 1. Some hosts in this area are aster, milkweed, Red clover and thistle. Expanse: 60-87 mm. Larvae are on violets.

Phyciodes tharos tharos (Drury)

Pearl Crescent

This common, smaller-sized butterfly is reddish-brown and is marked with wavy black lines and spots. It is lighter below, and there are small crescents on the outer edges of the hindwings. Adults appear in April and there are three broods. Clark (1932) reported that this species is the commonest butterfly of the region. I also found it to be the most numerous species in the park. In a detailed survey conducted in 1978, I found it throughout the park from April 30 to October 21 (Fales, 1978). At that time, it followed only the Cabbage butterfly and the Eastern-tailed blue in abundance. It visits numerous flowers including asters, milkweed, Mist flower (Eupatorium coelestinum) and Red clover. Park specimens measured 28-36 mm. in expanse. Larvae are on asters.

Polygonia interrogationis (Fabricius)

Question Mark

The Question Mark or Violet Tip is of medium size. It is orange-brown, and is marked with darker spots. The wings have irregular or broken-looking edges. The hindwings have tails with violet-colored edges. There is an inverted silver question sign on the underside. Forms also occur which have very dark hindwings. The adults overwinter and may be seen on warm winter days. They emerge from hibernation in April, and three broods follow. They may be seen throughout the season, and sometimes as late as November. Adults visit many plants, including milkweed and rotten fruits. Some park records are May 26

(Military Field), June 2 (Sherrill Drive meadow), and June 10, 30 and July 29 (Park Road meadow). Wagner (1941a) also found this species here on May 28 and July 21, 1935. Expanse: 50-71 mm. Larvae are on elm (*Ulmus* spp.) and nettles (Labiatae).

Polygonia comma (Harris)

Comma

This species is similar to the preceeding one, but is smaller and lacks the violet coloring. A silver comma is present on the underside of each hindwing. It also hibernates as an adult. Three broods follow the appearance of the first adults in March or April, and it is on the wing all season. Clark (1932) reported that it is frequent in the higher and drier woods in the park. Recent records were April 3, 1984 (Boundary Bridge), May 26 and September 11 (Sherrill Drive meadow), September 11 (Military Field), and May 19, October 3 and 21 (East Beach Drive). Expanse: 45-59 mm. Larvae are on elm and nettles.

Nymphalis antiopa antiopa (Linnaeus)

Mourning Cloak

This large butterfly is brownish-black with the outer wing margins edged with ivory-colored bands. Inside these bands are rows of small blue spots. Adults overwinter, and may be seen in flight on warm winter days. There are two broods, although late fall specimens may represent a third. Clark (1932) reported that this species was numerous in the park. Some of my records at the north end of the park are March 29; April 3, 7; June 30; September 28; and October 1 and 9. Specimens are usually collected on the wing, while resting on tree trunks or on the ground. Expanse: 63-85 mm. Larvae are generally on elm and willow (*Salix* spp.).

Vanessa virginiensis (Drury)

American Painted Lady

The forewings of this butterfly are a patchwork of browns and black, with dark margins. The tips of the forewings are black with small white spots, and there is a larger white bar inwardly. The bottom half of the underside of the forewings are pink, and the hindwings are marked with two large spots. It has three broods. It usually occurs from May to October, and overwinters as an adult. Clark (1932) reported a specimen from the park in mid-December, 1926. More recent records are May 30, and September 8 and 11. Adults visit many flowers including asters, azaleas, blackberry, Indian hemp, everlasting (Compositae), goldenrod, ironweed, milkweed and Red clover. Park specimens had expanses of 45-58 mm. Larvae are on everlasting and other composites.

Vanessa cardui (Linnaeus)

Painted Lady

This species is very similar to the preceeding one, except that the undersides of the hindwings have four smaller spots along the outer edges instead of the two large spots. It has three broods, and flies from May to October. However, it is irregular in occurrence, and in some seasons it does

not occur. I collected a female on October 6, 1947 at the North Portal area, but it was not seen in the park in recent surveys. Like the preceeding species, it is fond of flowers, especially Red clover. Expanse: 51-64 mm. Larvae are on nettle.

Vanessa atalanta rubria (Fruhstorfer)

Red Admiral

This colorful butterfly is brownish-black with red bands across the forewings, and along the outer edges of the hindwings. There are also white spots near the wing tips of the forewings. The red is lacking on the underside of the hindwings. The flight period is usually from May to October, but it occasionally appears in early spring. Park records are from May 19 to September 12 at Sherrill Drive and Madison-Carter Baron meadows. I also found it there on May 24, 1952. There are three broods. Specimens have been taken on aster, joe-pye weed, milkweed, dung and decaying fruit. They often rest on tree trunks and bare ground. Expanse: 46-63 mm. Larvae are on nettle.

Junonia coenia (Hubner)

Buckeye

This common species is one of the most beautiful of our butterflies. It is basically brown, and usually with dark light-ringed, blue-centered circles on the wings above and on the forewings below. There are also orange and black markings. Distinctive white bars cross the outer areas of the forewings. However, there is considerable variability. Overwintering adults may occur from March to May, when three broods follow. Late individuals are active some years into November. Recent park records were in August and September. Flower attractants include aster, Boneset (Eupatorium perfoliatum), joe-pye weed, marigold (Compositae), Queen Anne's lace and Red clover. Expanse of park specimens: 42-52 mm. Larval hosts include gerardia (Gerardia spp.), loosestrife (Lythraceae) and plantain (Plantaginaceae).

Basilarchia arthemis astyanax (Fabricius)

Red-Spotted Purple

This common, large butterfly has black forewings with small red spots on the tips, and blue hindwings. There is much red spotting beneath. There are three broods between May and October, and specimens may be found each month. An early record in the park was by D.H. Clemons on October 11, 1908 (Clark, 1932). Recent records were from August 21 to October 3. Adults are attracted to azalea, Bidens spp., dogwood, joe-pye weed, wild cherry, animal feces, mud and rotten fruit. Expanse: 57-92 mm. Some larval foods are Hornbeam (Carpinus caroliniana), poplar (Populus spp.), Scrub oak (Quercus ilicifolia), wild cherry and willow.

Basilarchia archippus archippus (Cramer)

Viceroy

This species has reddish-brown wings with black borders containing a single row of small white spots. The hindwings are crossed by a narrow black band, both above and below. It flies from may to October, and there are three broods. In recent studies this usually common butterfly was recorded only at Piney Branch meadow on September 5, 1978. It visits many flowers including everlastings, goldenrod and honeysuckle. Expanse: 51-89 mm. Larvae are on poplar and willow.

Family Apaturidae (Hackberry and Goatweed Butterflies)

Asterocampa celtis (Boisduval and Leconte)

Hackberry Butterfly

This species is brown with black and white spotting. A black spot is located near the outer margin of the forewing. The surfaces are lighter below, and there are rows of small blue, black and yellow spots on the hindwing. There are two broods between June and September. Although not seen recently in the park, this species was taken there by E. Shoemaker prior to 1932. It is rarely seen on flowers, but rests on leaves, the ground and various objects. Expanse: 41-55 mm. Larvae are on Hackberry.

Family Satyridae (Satyrs and Wood Nymphs)

Members of this family are medium-sized butterflies

Megisto cymela cymela (Cramer)

Little Wood Satyr

This brown butterfly has black, yellow-ringed spots on the outer wing margins, both above and below. It is lighter below with two thin transverse bands on both pairs of wings. This species is single-brooded, and it occurs from May to August. Clark (1932) reported it along Rock Creek, and I took a specimen in the northern area on June 26, 1949. In recent studies it was present at the Park Road meadow from June 2 to June 23. It was common on June 10. They are often found in deep grass and seldom visit flowers. Expanse of park specimens: 35-41 mm. Larvae are on grasses.

Cercyonis pegala alope (Fabricius)

Common Wood Nymph

This species, also called the Goggle Eye, is brown with a yellow block, which contains two darker spots on each forewing. There is a single brood, and adults fly from June to September. Clark (1932) found this species along the edges of woods in the park, and Wagner (1941a) collected a specimen there on July 6, 1935. In the 1920's and 1930's I found this species to be faily common in the northern area, however, it was not observed during surveys in the park in

1977 and 1978. There are three specimens in the park collection, one of which is dated July 6, 1962. It is rarely found on flowers but occurs instead on foliage, tree trunks and grass. The expanses of local specimens were 48-63 mm. Larvae are on grasses.

Family Danaidae (Monarchs)

Danaus plexippus (Linnaeus)

Monarch

The Monarch, a large butterfly, is one of the best known insects. It is reddish-brown with black margins containing two rows of white spots. There are white spots in the tips of the forewings, and the veins are black. Faded adults may be seen flying northward in April and May. From June on there may be four or five broods. A southward migration follows in September and October, and sometimes they are in great numbers during this period. The adults overwinter as far south as Mexico. Park records are from July 15 and September 25. Adults are attracted to many flowers including aster, everlasting, goldenrod, joe-pye weed, milkweed, mustard (Cruciferae) and Red clover. Expanse: 76-104 mm. The larvae are on milkweed.

Discussion

Of the 97 species of butterflies known from the District of Columbia, 58 have been recorded from Rock Creek Park. Five of these occurrences are based on relatively recent records (1972 or later). Three of those (Staphylus hayhurstii, Thymelicus lineola and Nastra lherminier) are recent arrivals in this area, and the others (Satyrium edwardsii and Calycopis cecrops) are rare forms that simply may have been missed in earlier studies.

In my surveys during 1977 and 1978, the most numerous species were Polites coras, Artogeia rapae, Everes comyntas, Phyciodes tharos, Poanes zabulon, Colias philodice, and Ancyloxypha numitor. Some of this information is generally comparable to the experience of Clark more than fifty years ago. In referring to Polites coras he (Clark, 1932) said, "Except for the Least Skipper (Ancyloxypha numitor) this is the most abundant of the smaller skippers in this region." In reference to Everes comyntas, he said, it is "one of the most abundant butterflies in the District." On commenting on Phyciodes tharos he said, it is "being, in fact the commonest butterfly of the region." However, of Artogeia rapae, he wrote "within this area the cabbage butterfly is very unequallly distributed. Briefly speaking, it is by no means so common as would be expected".

It is also interesting that some species found commonly in the older studies (Feniseca t. tarquinius and Cercyonis p. alope for instance) have not been found more recently. However, additional research will be required to determine if these subtle changes in the local butterfly fauna are the result of natural fluctuations, habitat modification or other factors.

These studies, old and new, provide a base-line for a better understanding of the species found about the research meadows, as well as throughout all of Rock Creek Park. It can be concluded that the butterfly fauna of Rock Creek

Table 1. Skippers and butterflies known from the District of Columbia that have not been reported from Rock Creek Park.

	Family and Species	Mar	Apr	May	June	July	Aug	Sept	Oct
		Adult Flight Period							
	Family Hesperiidae (Skippers)								
**	Autochton cellus (Boisduval & Leconte) Gold-banded Skipper			X	X	X	X		
*	Achalarus lyciades (Geyer) Hoary Edge Skipper			X	X	X	X		
	Thorybes bathyllus (J.E. Smith) Southern Cloudy Wing			X	X	X	X	X	
	Thorybes pylades (Scudder) Northern Cloudy Wing			X	X	X	X	X	
*	Thorybes confusis Bell Confused Cloudy Wing			X	X	X	X	X	
	Erynnis icelus (Scudder & Burgess) Dreamy Dusky Wing		X	X	X				
*	Erynnis brizo brizo (Boisduval & Leconte) Sleepy Dusky Wing		X	X	X				
*	Erynnis martialis (Scudder) Mottled Dusky Wing		X	X	X	X	X	X	
*	Erynnis baptisiae (Forbes) Wild Indigo Dusky Wing		X	X	X	X	X	X	
*	Pyrgus centaureae wyandot (W.H. Edwards) Grizzled Skipper		X	X					
	Lerema accius (J.E. Smith) Clouded Skipper					X	X	X	X
	Hylephila phyleus (Drury) Fiery Skipper				X	X	X	X	X
*	Hesperia leonardus Harris Leonard's Skipper							X	X
*	Hesperia metea metea Scudder Cobweb Skipper		X	X					
	Poanes hobomok (Harris) Northern Golden Skipper			X	X	X	X	X	
**	Poanes viator zizaniae Shapiro Broad-winged Skipper				X	X	X	X	X
*	Euphyes bimacula (Grote & Robinson) Two-spotted Skipper				X	X			
	Euphyes ruricola metacomet (Harris) Dun Skipper			X	X	X	X	X	
*	Atrytonopsis hianna hianna (Scudder) Dusted Skipper			X	X	X			
	Amblyscirtes vialis (W.H. Edwards) Roadside Skipper		X	X		X			
**	Lerodea eufala (W.H. Edwards) Eufala Skipper							X	
**	Calpodes ethlius (Stoll) Brazilian Skipper						X	X	
*	Panoquina ocola (W.H. Edwards) Ocola Skipper					X	X	X	X
	Family Papilionidae (Swallowtails)								
*	Heraclides cresphontes (Cramer) Giant Swallowtail			X	X	X	X	X	
**	Pterourus palamedes Drury Palamedes Swallowtail			X	X	X	X	X	

Table 1 (continued). Skippers and butterflies known from the District of Columbia that have not been reported from Rock Creek Park.

	Family and Species	Mar	Apr	May	June	July	Aug	Sept	Oct
		Adult Flight Period							
	Family Pieridae (Whites and Sulfurs)								
*	Phoebis sennae eubule (Linnaeus) Cloudless Sulfur		X			X	X	X	X
**	Eurema daira daira (Godart) Barred Sulfur					X			
	Family Lycaenidae (Gossamer-Winged Butterflies)								
*	Hyllolycaena hyllus (Cramer) Bronze Copper				X	X	X	X	
*	Harkenclenus titus mopsus (Hubner) Coral Hairstreak				X	X			
	Callophrys augustus croesoides Scudder Brown Elfin		X	X					
*	Callophrys irus irus (Godart) Frosted Elfin		X	X					
*	Euristrymon ontario ontario (Edwards) Northern Hairstreak				X				
*	Parrhasius m-album (Boisduval & Leconte) White M Hairstreak		X		X	X	X	X	
	Family Nymphalidae (Brush-Footed Butterflies)								
**	Speyeria aphrodite aphrodite (Fabricius) Aphrodite Fritillary				X	X	X		
**	Speyeria idalia (Drury) Regal Fritillary				X	X	X	X	
**	Euphydryas phaeton phaeton (Drury) Baltimore			X	X	X			
**	Polygonia progne (Cramer) Gray Comma	X		X	X	X	X	X	
	Family Apturidae (Hackbery and Goatweed Butterflies)								
	Asterocampa clyton (Boisduval & Leconte) Tawny Emperor				X	X	X	X	
	Family Satyridae (Satyrs and Wood Nymphs)								
*	Satyrodes appalachia leeuwi (Gatrelle & Arbogast) Appalachian Eyed Brown				X	X	X	X	

* Denotes species considered rare in this area. ** Denotes species formerly present but now absent from this area, as well as those that I consider to be strays.

Park includes a majority of the species known from the local area. Also, it can be expected that the further development of the research meadows by the National Park Service will help in attracting additional species.

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Ecphora; Important Fossil From The Miocene Strata On The Chesapeake Bay

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Introduction

As one walks along the narrow sandy beaches of southern Maryland on the western shore of the Chesapeake Bay, one quickly becomes aware of a different time, a much earlier time, a time when ancient seas invaded the land and left behind a geologic record rich in fossil remains. Today this record is exposed in wave-cut cliffs bordering the Chesapeake Bay and its tributaries (Figure 1). The strata in these cliffs preserve a significant part of the geologic history of the area and the evolutionary history of its prehistoric plants and animals which are now preserved as fossils. The most abundant fossils in the cliffs are the mollusks, some of which are still living but most of which are extinct.

On close inspection of the cliffs one may see a bit of russet color and discover that it is produced by the surface of a large graceful snail shell which can be distinguished by its strongly developed, high ribs and its rather widely flaring umbilicus. This shell is also characterized by its reddish-amber color which contrasts with the white color of other mollusks. This is the Genus *Ecphora*, which rivals shark teeth in its popularity with collectors. Extinct for some 3 million years, this fossil muricid gastropod is found in all three of Maryland's Miocene formations, which are, from oldest to youngest, the Calvert, Choptank, and St. Marys. It is also found in other Miocene and Pliocene formations from New Jersey to Florida. *Ecphora* is known to paleontologists as an index fossil, or one that is used to recognize and correlate geological strata of similar age.

For more than 200 years *Ecphora* has been a much sought-after prize for collectors of both Holocene and older shells and has become a paleontological symbol. *Ecphora* has been illustrated in numerous journals and appears in the logo of the Paleontological Research Institution. On May 14, 1984 Governor Harry Hughes signed Senate Bill 193, now Chapter 313 of the Acts of the General Assembly of Maryland, designating the *Ecphora* from the St. Marys Formation on the St. Marys River as the official state fossil (Figure 2). The name traditionally associated with this St. Marys *Ecphora* is *Ecphora quadricostata* (see Martin, 1904). More recently, it has been widely recognized that the name *Ecphora quadricostata* actually belongs to a different species, from the Yorktown Formation in Virginia (Figure 3). Accordingly, the St. Marys species and the official state fossil will be receiving its own new name (Wilson, in press), even though the fossil itself will be the same, familiar, heavy-ribbed form known to scientists, students, and collectors for scores of years.

Geological And Biological History of *Ecphora*

The Genus *Ecphora* probably originated in Oligocene time, around 30 million years ago. *Ecphora* has been reported (Wade, 1926; Sohl, 1964) from Upper Cretaceous sediments in Tennessee and Mississippi, but the Cretaceous

The Maryland Naturalist 31(1):25-33.

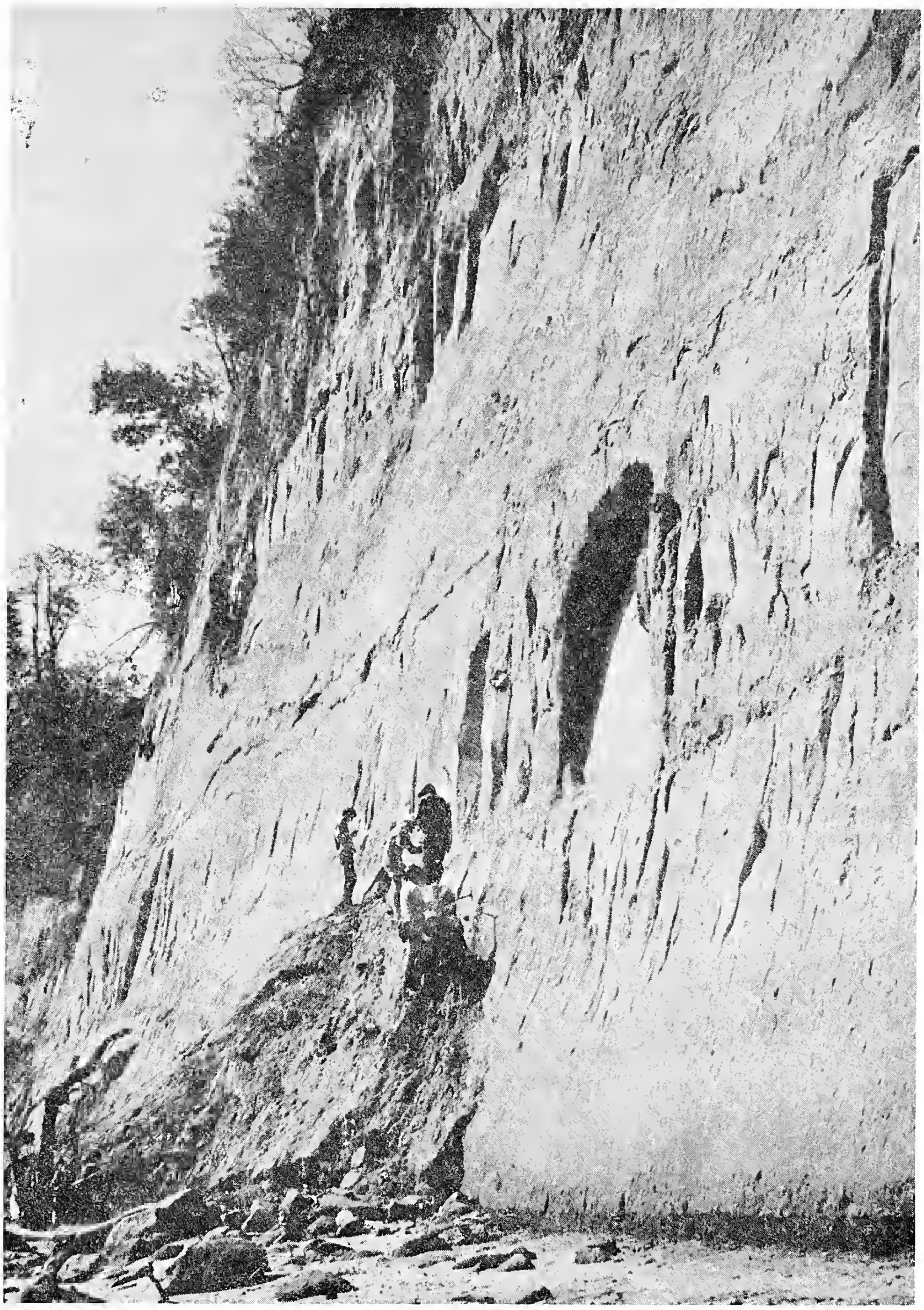


Figure 1. Cliff just south of Plum Point, Calvert County, Maryland. Cliffs such as this should be approached only with caution. It is possible though not likely, for them to collapse on a would-be collector. Bed 10 of the Calvert Formation is at sea level. The geologists are sampling Bed 12 of the Calvert. Persons in the photograph are Drs. William H. Abbott and Alan-Jon W. Zupan, both then of the South Carolina Geological Survey, Dr. Douglas F. Williams of the University of South Carolina, and Dr. Blake W. Blackwelder then of the U.S. Geological Survey. Abbott is now with Mobil Oil, Dallas, Texas and Blackwelder is with Tenneco, Houston, Texas. (Photo by L. W. Ward, 1979).

species lacks the translucent brown outer shell layer of Miocene Ecphora. For this reason, the authors believe that the Cretaceous form is unrelated to the Miocene stock and is not considered here. Judging from the sediments in which Ecphora is found and its associated marine assemblages, the gastropod is believed to have lived in the open sea on the inner to middle continential shelf during a time of extreme environmental shifts between cool and subtropical conditions. Ecphora apparently was a predatory gastropod that probably fed upon other gastropods, bivalves, sedentary polychaete worms, crustaceans, echinoids, brachiopods, and corals, all of which were common in the seas at that time. It may have fed by boring holes in the shells of other animals using its radula, a series of rasp-like chitonous teeth, and secretions from an accessory boring organ located in its foot. Such boreholes are present in many of the Miocene shells in Maryland, but these holes may have had other origins, because other snail genera such as Urosalpinx and Lunatia were also borers. After a long geologic history, Ecphora became extinct in the late Pliocene (Blackwelder, 1981) during a period of apparently extreme cooling which caused the demise of numerous other marine species at the same general time.

Nomenclatural History of Ecphora

The scientific records concerning Ecphora begin in 1770 with an illustration appearing in William Huddesford's third edition of Martin Lister's "Historia Conchylorium" (Figure 4). Beginning as a small octavo work printed in 1685 under the name "de Cochleis" and consisting of copper plate engravings of land snails, this modest publication was circulated privately among Lister's friends (Wilkins, 1957; Dance, 1966, 1986). Lister immediately launched into an expanded second version, in which he intended to include all living and extinct freshwater and marine shells then known (Wilkins, 1957). "Historia Conchyliorum" was the first practical attempt at a systematic arrangement on conchology (Wilkins, 1957). Lister, upon his death in 1712, left all of his original copper plates to the Ashmolean Museum where, in 1770, William Huddesford, then curator, published the so-called third edition of "Historia Conchyliorum", complete in one volume and containing all that was in the "second edition" plus extra plates and six pages of notes from Lister's handwritten manuscript (Wilkins, 1957). The illustration of Ecphora (at that time unnamed) appeared on the last plate, numbered 1059.2, with only the note "a marilandia" meaning "from Maryland". The Huddesford edition was published under the patronage of Margaret Cavendish Bentinck, Second Duchess of Portland (Dance, 1966, 1986). After her death in 1785 the extensive collections of the Portland Museum were sold at auction. The catalogue prepared for this action listed as lot number 3516 "a very curious and rare species of Buccinum in a fossil state, having four high sharp ridges, from Maryland, very rare -- Lister, 1059.2". Lot 3516, apparently containing the Ecphora, was purchased by J. Bell of London, one of the proprietors of the "Morning Post" and Bookseller to His Royal Highness the Prince of Wales, London (Salisbury, 1945). No information is available on the present whereabouts of the fossil.

There are several possible sources for Lister's Ecphora illustration in the Huddesford edition. Most of the leading English naturalists of the day were members of the Temple Coffee House Botany Club near London. Among its members were Sir Hans Sloane, James Petiver, William Sherard, S. Robert Plukenet, William Charleton, and Martin Lister. John Banister, a young minister and botanist, arrived in Virginia in 1678 and began immediately to compile a plant catalogue and send botanical specimens as well as land snails and fossils back

Figure 2. The state fossil of Maryland (after Martin, 1904) from the St. Marys River, St. Marys County, Maryland. This species is being named by Druid Wilson (in press).

Figure 3. Ecphora quadricostata (Say, 1824). This photograph is the first known published of the holotype (British Museum, Natural History, GG 12661). Notice that the ribs are much thinner than those of the St. Mary's species, which are higher on the body whorl and decidely T-shaped. John Finch is believed to have found this specimen at Yorktown, Virginia. (Photo by B. W. Blackwelder and L. W. Ward).

Figure 4. Martin Lister's figure of the shell from Maryland believed to be an Ecphora. (after Martin, 1904).

Figure 5. Ecphora tricostata Martin, 1904. This species is known only from Bed 10 of the Calvert Formation in Maryland and from the Pungo River Formation in North Carolina. (after Martin, 1904).

Figure 6. Ecphora ecclesiastica (Dall, 1915). Occurs in the lower part of the Calvert Formation in Queen Annes County, Maryland. (after Martin, 1904).

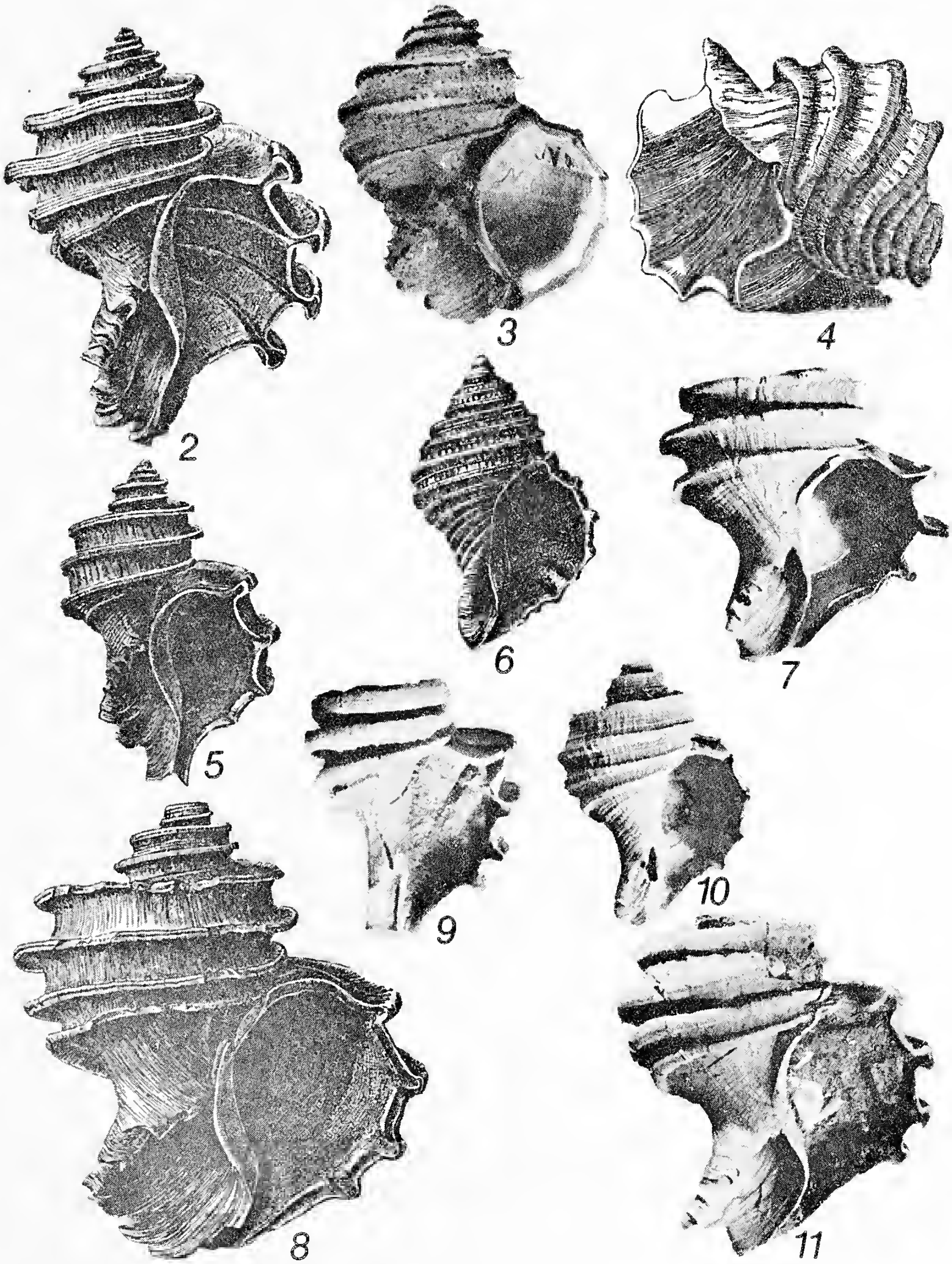
Figure 7. Ecphora sp. This unnamed species of Ecphora occurs in Beds 14 through 17 in the Calvert and Choptank Formations. The figured specimen comes from Bed 14 of the Calvert at Scientists Cliffs, Calvert County, Maryland.

Figure 8. Ecphora sp. An unnamed species mistakenly called E. quadricostata var. umbilicata by Martin, 1904. Fusus umbilicata actually is a form from the Yorktown Formation in Virginia and is a junior synonym of E. quadricostata. This unnamed species ranges from Bed 14 of the Calvert Formation to Bed 18 of the Choptank Formation. The figured specimen is from Bed 17 at Drumcliff, St. Marys County, Maryland. (after Martin, 1904).

Figure 9. Ecphora sp. A rare species that is known to occur only in Bed 14 of the Calvert Formation. Figured specimen is from Fones Cliffs, Richmond County, Virginia. (Photo B. W. Blackwelder and L. W. Ward).

Figure 10. Ecphora sp. An unusual unnamed species that is known to occur only in Bed 17 of the Choptank Formation. The figured specimen comes from Drumcliff, St. Marys County, Maryland. (Photo by B. W. Blackwelder and L. W. Ward).

Figure 11. Ecphora sp. An unnamed, thick-ribbed species known only from Bed 19 of the Choptank Formation. The species appears to be the precursor to the heavy-ribbed St. Marys Ecphora. (Photo by B. W. Blackwelder and L. W. Ward).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to England to various members of the Temple Coffee House Botany Club (Ewan and Ewan, 1970). Banister was a talented illustrator and an astute collector of the flora and fauna of Virginia. Specimens of freshwater, land, and fossil shells along with correspondence from Banister to Martin Lister are recorded by Ewan and Ewan in their book on John Banister published in 1970. It remains unclear whether the members of the Temple Coffee House Botany Club financed Banister as they did later naturalists in the new world. After the untimely death of Banister in 1692, Hugh Jones came to Maryland in 1696 to collect plants, insects, fossils and shells and also to become the Minister in Christ Church Parish, Calvert County, Maryland (Ewan and Ewan, 1970; Ray, in press). In addition to Hugh Jones, the "Botany Club" sent William Vernon and David Krieg on a joint collecting expedition to Maryland. One of these three men, Hugh Jones, William Vernon, or David Krieg, all of whom collected in Maryland, seems the most likely source of the specimen of Ecphora illustrated in the Huddesford edition of "Historia Conchyliorum", because the caption on plate 1059.2 reads "a marilandia".

The illustration of Ecphora in the Huddesford edition (1770) has been said by several authors (Shattuck, 1904; Vokes, 1957) to be the earliest figured American fossil, but Ward and Blackwelder (1975) pointed out that this honor probably should go to Chesapecten jeffersonius (Say, 1824), which was illustrated and described (but not named) by Lister in 1687 (see also Ray, in press).

In 1824, Thomas Say of the Academy of Natural Sciences of Philadelphia was the first to name a species of the genus Ecphora, calling it Fusus 4-costatus (see Figure 3). Later, T. A. Conrad (1843) gave Say's specimen a new generic name, Ecphora. Say's (1824) description was based on specimens given to him by John Finch, Professor of Geology, Birmingham University, Birmingham, England. Finch had indicated (apparently by word of mouth) that he collected these specimens in Maryland on the St. Marys River, so that Say reported the species, and others, from that locality. Although Finch (1833, p. 273) later described where he obtained the Virginia collection (Yorktown, Va.), he never formally corrected Say's mistake, thus perpetuating the misinformation. Later investigations by Ward have shown that none of the specimens described from the Finch collection came from Maryland, but rather from the Eastover and Yorktown Formations in the vicinity of Yorktown, Virginia.

The first Ecphora actually described from Maryland was Ecphora tricostata Martin, 1904 (Figure 5) from the Calvert Formation. Martin also figured and described a small specimen from Calvert beds at Church Hill on the Eastern Shore in Queen Anne County (Figure 6), but he incorrectly called it "Ecphora tampaensis", a species from the Florida Miocene. This misidentification was corrected by Dall (1915) when he named the specimen from Church Hill, "ecclesiastica". Wilson (in press) has excluded ecclesiastica from the genus Ecphora.

Evolutionary Lineage of Ecphora

In spite of the fact that the Calvert, Choptank, and St. Marys Formations in Maryland contain an extraordinarily complete evolutionary sequence of Ecphora, only Ecphora tricostata and Ecphora ecclesiastica have been named to date. Druid Wilson (National Museum of Natural History) has several

names in press, some of which certainly will be applied to Maryland forms; one to the St. Marys species and one to a Calvert species. Several species, however, remain unnamed. Among these are two that range from the upper Calvert to the lower Choptank (Figures 7, 8), one restricted to the upper Calvert (Figure 9), one restricted to the lower Choptank (Figure 10), and one restricted to the upper Choptank (Figure 11). Two additional unnamed species (not figured) occur in the Eastover Formation (upper Miocene) in Virginia.

Maryland Collecting Localities

Several localities in Maryland are especially productive for collecting Ecphora. Bed 10 (Shattuck, 1904) of the Calvert Formation, which is exposed from below Chesapeake Beach to below Plum Point in Calvert County, contains abundant Ecphora tricostata (Fig. 5), but most are crushed in place and require time-consuming extraction and restoration. This is true also for Bed 14 of the Calvert, in the vicinity of Scientists Cliffs and Governors Run, where several unnamed species (Figs. 7, 8, 9) are common. In contrast, Bed 17 of the Choptank Formation at Drumcliff on the Patuxent River, St. Marys County contains numerous, relatively well-preserved specimens of several species (Figs. 7, 8, 10). The best specimens of Ecphora can be obtained from the St. Marys Formation (Fig. 2), notably from two general localities: Little Cove Point, western shore of Chesapeake Bay, Calvert County and Chancellor Point, St. Marys River, St. Marys County. As in all fossil collecting localities, would-be collectors must receive permission to hunt on private or state-owned land. Only when such permission is granted is it possible to collect fossils legally. Failure to get permission can only make it increasingly difficult to gain access to favorite localities in the future.

Conclusions

Ecphora is well represented in the Miocene and Pliocene beds of Maryland and Virginia. In Maryland, a nearly continuous sequence of Miocene beds contains a remarkable evolutionary series of that marine gastropod. Although the unique morphology of Ecphora has long made it a favorite of scientists and amateurs, only recently have studies been initiated concening its morphology and evolutionary history. Its relatively long geologic history and distinctive changes in form during that interval may make it a potentially important example of the dynamics of evolutionary processes.

Acknowledgements

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Phantom Calcite Crystals From Carroll County, Maryland

Fred J. Parker

Large, multiple growth calcite crystals were found at the Genstar-Medford Quarry near Westminster, Carroll County, Maryland. These finds of late 1985 and early 1986 consisted of several very large pockets and hundreds of smaller pockets in a cavernous zone within the Wakefield Marble. The mineralogical importance of the occurrance was the abundance of large phantom (multiple growth) calcite crystals. The mineralized zone is now obliterated and access to the quarry is strictly prohibited.

The Medford Quarry is apparently the Hyde Quarry described by Ostrander and Price (1940) as containing calcite, quartz, pyrite, malachite, and other minerals typical of marbles. The rare mineral lanthanite was later reported as small pink radiating crystals in cavities in slate (Roe, 1975). About 1975 a zone containing secondary copper minerals including aurichalcite, malachite, and rosasite was also encountered (M. Elwood, personal communication).

The calcite crystals were encountered during removal of a highly fractured, cavernous zone in the Paleozoic Wakefield Marble on the lower level of the quarry. These crystals were deposited by mineral-rich waters in fractures and solution cavities. At least three large cavities ranging to about five feet in length and several feet high were uncovered in the wall, along with hundreds of smaller pockets. Singly terminated, and a few doubly terminated crystals up to ten inches long were collected. Crystals were generally drab brown to gray or milky white in color, although a limited number of smaller, salmon pink to honey yellow crystals were also found.

The crystals were nearly all phantom growths, reflecting two to three stages of mineral deposition. Most contained a white to purple core which flouresced red under short-wave ultraviolet radiation. This red flourescense is generally attributed to manganese trace impurities in the calcite. A second calcite growth, usually drab in color due to mud or metal (iron and/or manganese) oxide coloration, covered the primary crystal. This generation was generally less than 0.5 inches in thickness. Third generation growth was present on the same crystals, either as thin, lustrous, colorless coatings or as complex colorless to white crystal growths. The presence of these multiple calcite generations clearly showed the outlines of the earlier crystals when held up to a light source. The abundance of such phantom growths at the Medford Quarry is remarkable.

The majority of these crystals exhibited common crystallographic habits. However, many exhibited several forms simultaneously, making them crystallographically complex. The primary crystals were simple scalenohedrons, but complex rhombic and nailhead forms, as well as parallel growths and butterfly twins were also found.

The Maryland Naturalist 31(1):34-36.

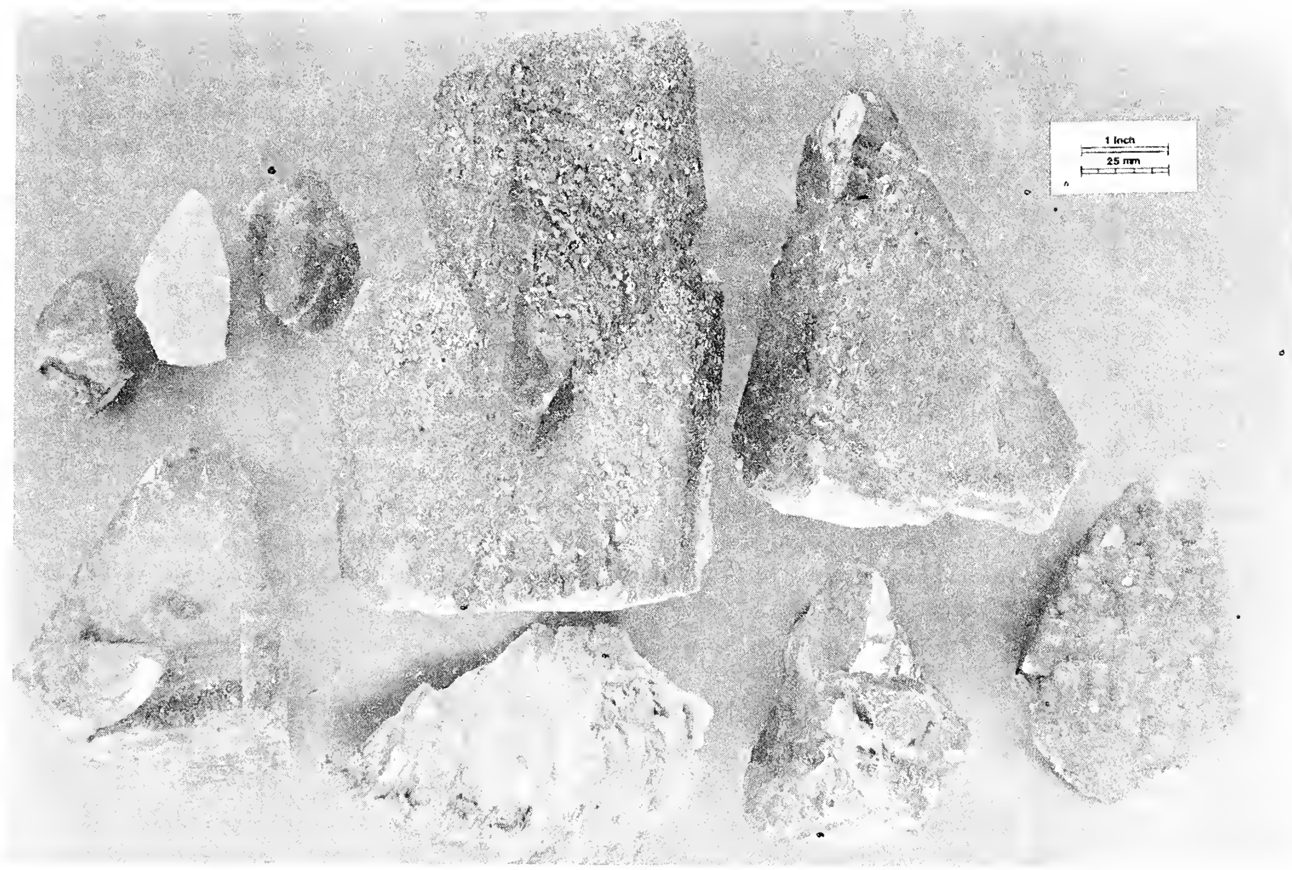

Figure 1. Series of crystals from Genstar-Medford Quarry showing crystal habits described in this paper.

A second, unique calcite occurrence consisted of lusterous white to brown platy crystals totally covering large knobs in a single pocket above five feet in length. The platy habit and dense nature of these crystals closely resembled barite, but chemical tests confirmed that they were calcite. Ten to fifteen good specimens were recovered from this pocket.

Entry into the Genstar-Medford Quarry is now strictly forbidden. Prior to early 1986, sporadic permission has been granted, but, due to a series of regretable actions by one or two collectors, this privilege was discontinued. The quarry subsequently changed ownership but this policy has not been changed. It has been reported that the cavernous zone containing the crystals has been removed, making collection of additional specimens unlikely.

The author gratefully acknowledges Genstar Corporation and Mr. Gene Larrick of the Medford Quarry for their cooperation and understanding toward serious collectors prior to the incidents which led to the closing of the quarry.

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The Occurrence of the Freshwater Jellyfish, Craspedacusta sowerbyi, In Maryland

Susan E. Rivers

In 1982 I received two reports of the occurrence of the freshwater jellyfish, Craspedacusta sowerbyi Lankester, in Maryland waters. The first siting was reported to me by the owner of a private pond in southwestern Washington County and the second was made by a Maryland Department of Natural Resources fisheries crew conducting a night survey of Clopper Lake in Montgomery County. Both sites were artificial impoundments that were used frequently during the summer months for aquatic recreational activities, yet no sitings of the species had ever been reported in either area. (Clopper Lake was completed in 1977, while the private pond was completed in the late 1960's.) A check of available sources failed to reveal any previous sitings of the freshwater jellyfish in the state of Maryland.

Since I had never heard of a freshwater jellyfish I must admit that I was initially more than just a little skeptical, especially when a visit to the Washington County pond revealed no specimens. However, the landowner insisted that they appeared at dusk, so by waiting until dark I was able to observe numerous individuals and collect some small jellyfish to take back to my office. I was able to keep these specimens alive for about two weeks in an aquarium by feeding them crustaceans from the Albert Powell Hatchery spring. During this time, I was able to confirm the identification of the species.

Jellyfish, or medusa, are abundant in marine waters, but truly freshwater species are rare. In addition to C. sowerbyi, there are only a few other species of Craspedacusta in China and Japan, and several Limnocnida in India and Africa (Hutchinson, 1967; Pennak, 1978). Craspedacusta sowerbyi is the only one found in North America, where it has been previously reported from most states east of the Great Plains and several western localities (Hyman, 1959). In addition to North America, C. sowerbyi has been reported from Canada, South America, the West Indies, England, Europe and China (Hutchinson, 1967; Pennak, 1978; Reid, 1965; Russell-Hunter, 1970).

The life history of C. sowerbyi is interesting. It remains dormant in a feeder stream for long periods as a hydra-shaped polyp. The polyp remains inconspicuous on the bottom sediments until conditions favor the medusal stage. Then, medusae begin to bud off to become free swimming. This is not a regular occurrence, and medusae may not appear for many years. However, when they do appear, they tend to occur between July and October (Pennak, 1978), perhaps in response to changes in water temperature (Barnes, 1974).

The medusae are umbrella-shaped and the bell is fringed with numerous tentacles that are used for feeding and swimming (Figure 1). They swim to the surface of the lake or pond by rhythmic contractions of the bell and then float down through the water column with their tentacles extended to capture food. Statocysts (stinging cells) paralyze rotifers and planktonic crustaceans which are then ingested (Amos, 1967; Barnes, 1980; Hutchinson, 1967; Pennak, 1978).

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Figure 1. Craspedacusta sowerbyi collected August 1982 in Washington County Pond. Individual illustrated is about 10 mm in diameter.

The appearance of medusae is often explosive, with millions of dime to quarter sized jellyfish swimming through the water. When they occur in North American waters they all tend to be one sex (Hutchinson, 1967; Pennak, 1978). Nevertheless, they are capable of reproducing either asexually or sexually. Asexual reproduction occurs when they are expanding their numbers rapidly. With this method, small medusae simply bud off of the bell-shaped vellum to become new individuals. When conditions begin to deteriorate, the medusae begin to produce sexual gametes. After fertilization, the eggs hatch and become motile planula larvae. These larvae swim back to the feeder streams where they settle to the bottom and transform into inconspicuous polyps (Barnes, 1980; Pennak, 1978).

Although much is still to be learned about this creature, long term study is made difficult by the sporadic occurrence of the medusae, and the fact that the polyps are easily confused with other species of hydroids (Hutchinson, 1967). To this date, medusae have apparently not reappeared at either of the two known Maryland sites. However, when conditions are suitable, C. sowerbyi will again appear, giving us another chance to learn more about one of Maryland's oddest aquatic creatures.

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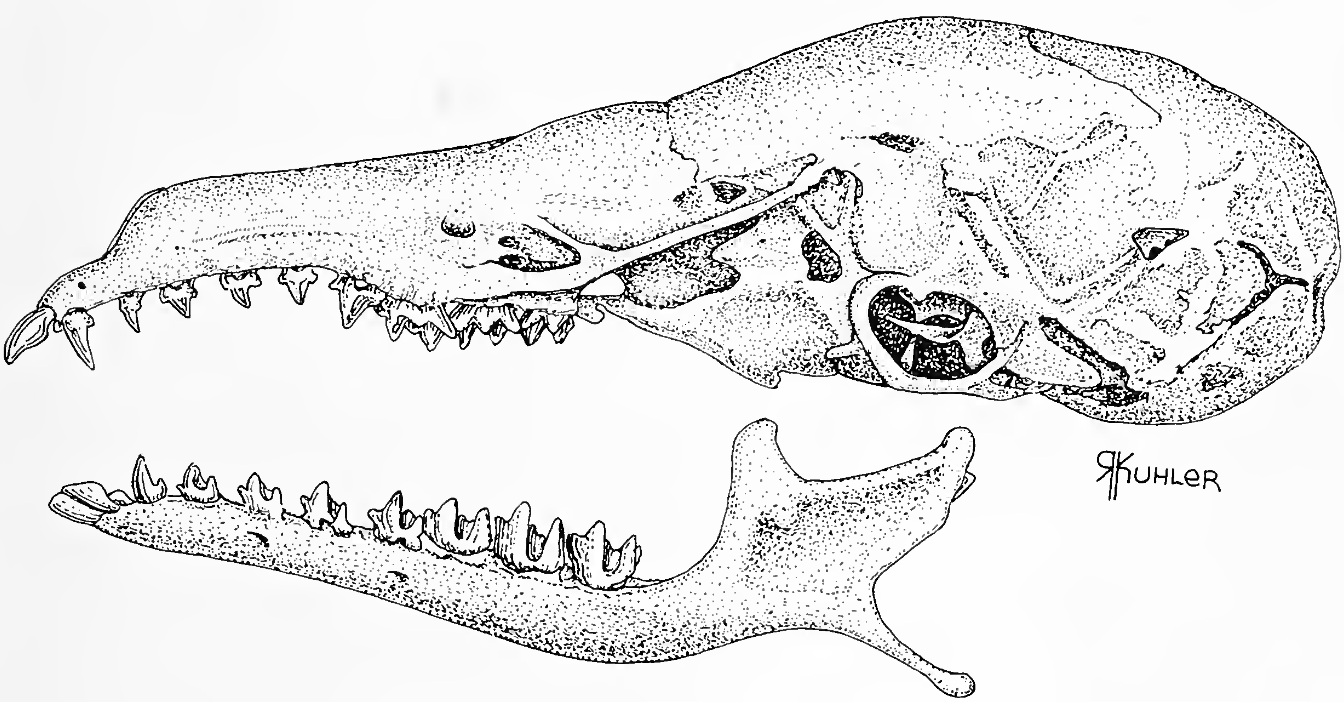

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Cover Illustration: Skull of the Star-nosed Mole, *Candylura cristata*. Original drawing by Renaldo Kuhler. Reproduced with permission from the North Carolina State Museum of Natural Sciences.

Density Fluctuations in a Meadow Vole Population at the Patuxent Wildlife Research Center

David A. Jett and James D. Nichols

Vole, lemming, and other small rodent "outbreaks" have fascinated naturalists for decades. For nearly half a century, there has been active interest in small mammals that undergo multi-annual fluctuations in some parts of their range (see Krebs & Myers 1974, Taitt and Krebs 1985 for reviews). Several species of small mammals have been studied extensively to determine the pattern of density changes over long periods of time. There seems to be what is best characterized as a continuum of populations extending from those that exhibit only annual fluctuations ("non-cyclic") to those that undergo distinct patterns of density rises and falls over several years ("cyclic"). Many times a single population will exhibit both types of changes at different times.

We studied the Meadow vole (*Microtus pennsylvanicus*) in old-field habitat at the Patuxent Wildlife Research Center in Laurel, Maryland from 1980 to 1984. Initially, our studies were directed at testing the efficacy of a new capture-recapture design and associated estimators (Nichols et al. 1984). Later, we used the study population as the "control" in an experiment involving pesticide effects on meadow voles (Jett 1986, Jett et al. 1986).

Meadow voles were trapped with 100 live-traps arranged in a 10 by 10 pattern on a 0.4 ha grid. Trapping was conducted at approximately monthly intervals with few exceptions. Voles were marked with individually numbered ear tags, and tag numbers were recorded for all captures (see Jett et al. 1986 and Nichols et al. 1984 for detailed explanation of field procedures). Population size for each time period was estimated from combined capture data for adults and subadults (>21 g) of both sexes using the Jolly-Seber estimator (Seber 1982).

Changes in estimated population size on the trapping grid are illustrated in Fig. 1. Large fluctuations occurred within and among years. Annual fluctuations were characterized by typical spring declines and early summer and fall increases. *Microtus* population size peaked in December 1981 with an estimated 157 individuals and reached a low of 8 individuals in June 1983. There was an increase in the population to peak numbers in 1981 followed by a gradual decline that lasted over a year. Low numbers then persisted for seven months until trapping was terminated. We again began trapping on the grid nine months later in late summer 1984 when the population was increasing and approaching levels observed in 1980 and 1981.

The pattern of density changes observed for this *Microtus* population indicates that a multi-annual fluctuation occurred during the period of study. Taitt and Krebs (1985) examined data for several *Microtus* species studied in North America and observed that populations undergoing multi-annual fluctuations generally reached maximum densities 2-3 times larger than those of non-cycling populations. One exception to this observation was *M. pennsylvanicus* for which maximum densities were similar for populations undergoing both annual and

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multi-annual fluctuations (Taitt and Krebs, Table 7). The population we studied reached a maximum approximately twice as large as the average for this species reported by Taitt and Krebs (1985).

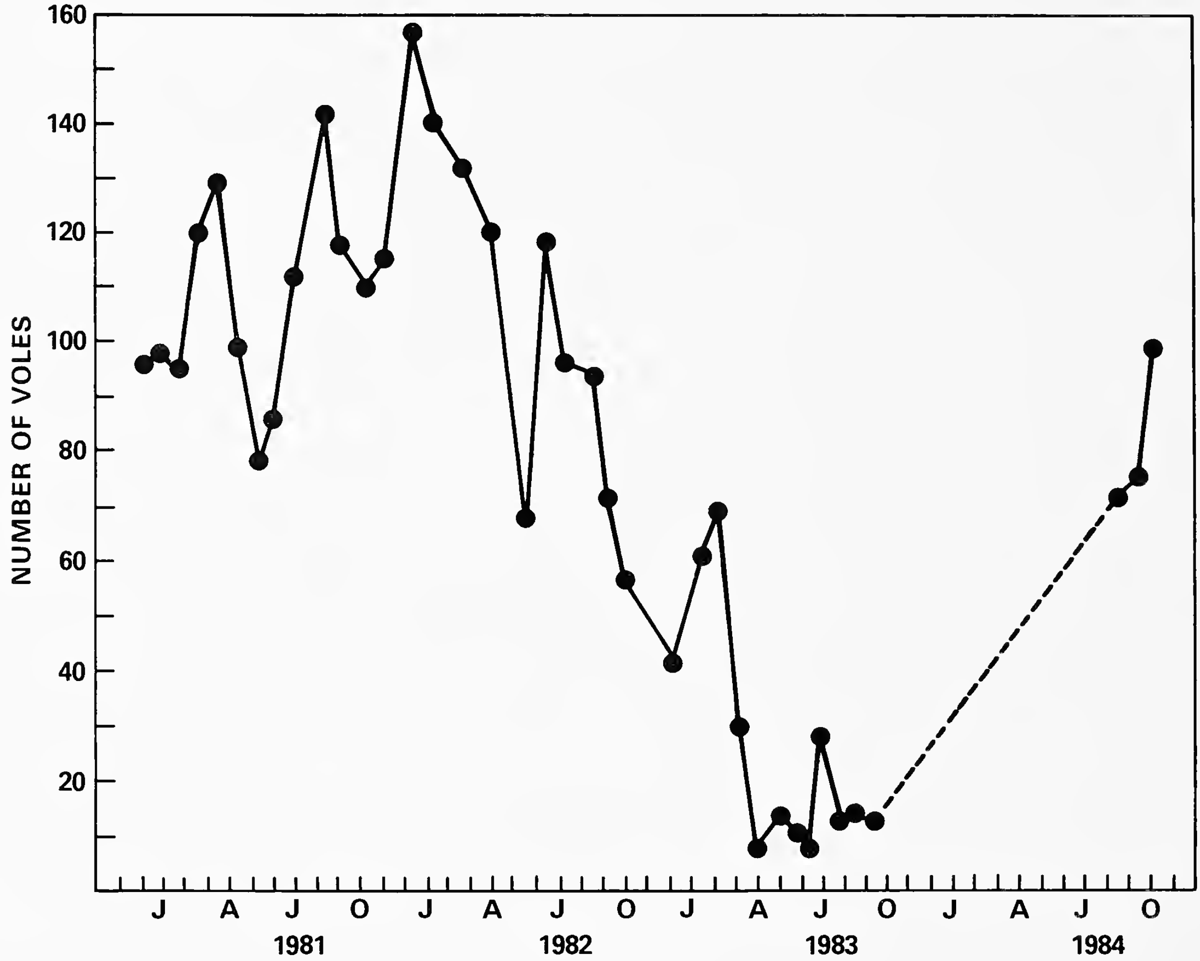

Fig. 1. Meadow vole population size on a 0.4 ha trapping grid in old-field habitat at the Patuxent Wildlife Research Center.

Taitt and Krebs (1985) also found two other general patterns in the North American *Microtus* data. First, the amplitude of fluctuations was always less than 5-fold in annual populations and more than 10-fold in cycling populations. Our results concur with their observations on cyclic populations. Second, they found that spring declines were larger in annual than in cycling populations. Spring declines were observed in our population but were not as large as those often found in annual populations (Fig. 1).

Long-term data, perhaps spanning 20 years or more, are needed to thoroughly characterize density fluctuations of Microtus in Maryland. Our data suggest that some populations of the meadow vole in Maryland can reach very high densities and that they undergo multi-annual fluctuations during some periods.

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The Star-nosed Mole on the Delmarva Peninsula: Zoogeographic and Systematic Problems of a Boreal Species in the South

David S. Lee

All three species of eastern North American moles occur in Maryland. By far the most common and widespread species is the Eastern mole (*Scalopus aquaticus*) which occurs throughout the Coastal Plain and Piedmont in most upland habitats. The Hairy-tailed mole (*Parascalops breweri*) is confined to mountain areas in the western portion of the state and is not particularly common. The Star-nosed mole (*Condylura cristata*) is also uncommon and is largely restricted to stream banks, bogs, spring-runs, and other areas of moist soils. Although *C. cristata* is generally regarded as occurring throughout Maryland, this is apparently not the case. Furthermore, its subspecific identification in Maryland is not clear. I here describe the local distribution of the Star-nosed mole and discuss the systematics of Maryland's populations. I also address the relationship of the distribution of *C. cristata* in Maryland to that of the species in the southeastern United States as a whole.

North American moles are widespread and in diverse habitats. Their meandering subsurface runways made in their constant search for food are a familiar site, yet many people have never seen a live mole. Little is known about mole biology, one of the least studied components of North American mammalian fauna. Skulls of the three species of eastern North American moles are illustrated in Figure 1. Of these, the most bizarre is the semi-aquatic Star-nosed mole with a ring of 22 fleshy appendages around its nose. These are probably tactile, but their true function is not known. Figure 2 compares the external appearance of the Eastern mole and *C. cristata*.

The Star-nosed mole is essentially a species of the northeastern United States and eastern Canada. As in the case of some other boreal mammals, small, often disjunct populations occur in the Southeast as Pleistocene relicts. Fossil *C. cristata* have been found in Pennsylvania, Maryland, Virginia, West Virginia, and Tennessee, all areas within its current range. A fossil from Missouri indicates that this mole once had a larger range in North America (Guilday et al. 1964, Hutchison 1968, Parmalee et al. 1969). The oldest North American specimens date back to 700,000 years B.P. (Guilday 1979). *Condylura* is also known from two fossil European species *C. kowalski* and *C. izabellae* of the middle and late Pliocene, but only the North American *C. cristata* is extant. Detailed descriptions and life history information on Star-nosed moles are available in various publications, with a good summary provided by Peterson and Yates (1980).

Figure 1. Skulls of the three genera of moles occurring in eastern North America. A dorsal, B ventral, and C lateral views of the skull of a Hairy-tailed mole (*Parascalops breweri*) NCSM 3297, female, NC, Jackson County, 3.75 mi E Cashiers, 22 June 1980. Skull length 30.0 mm. D dorsal, E ventral and F lateral views of the skull of a Eastern mole (*Scalopus aquaticus*) NCSM 845, male, NC, Wake County Raleigh 25 April 1965. Skull length 33.5 mm. G dorsal, H ventral, and I lateral views of the skull of a Star-nosed mole (*Condylura cristata*) NCSM 3047, male, NC, Scotland County, Laurinburg 12 April 1975. Skull length 32.5 mm.

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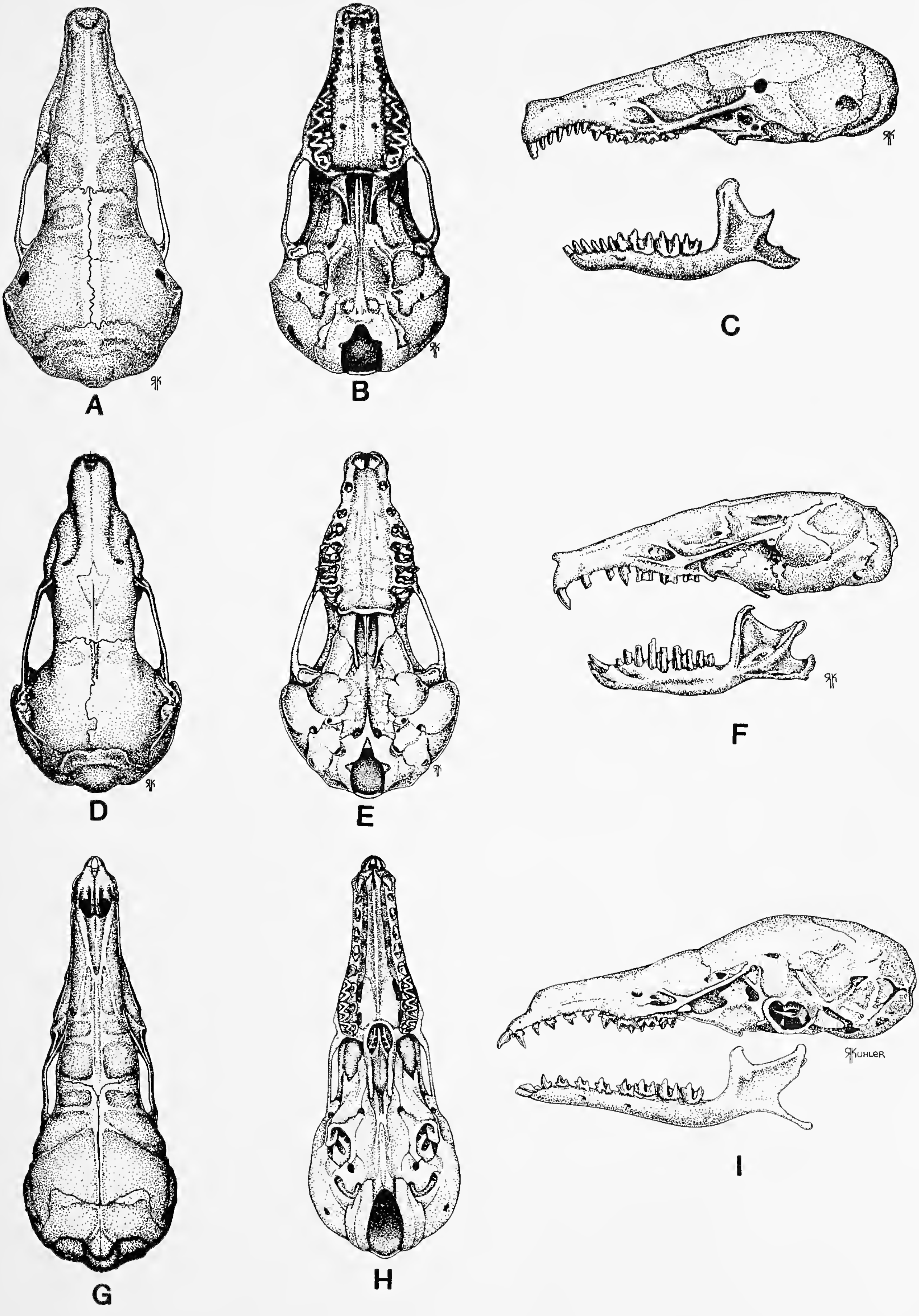
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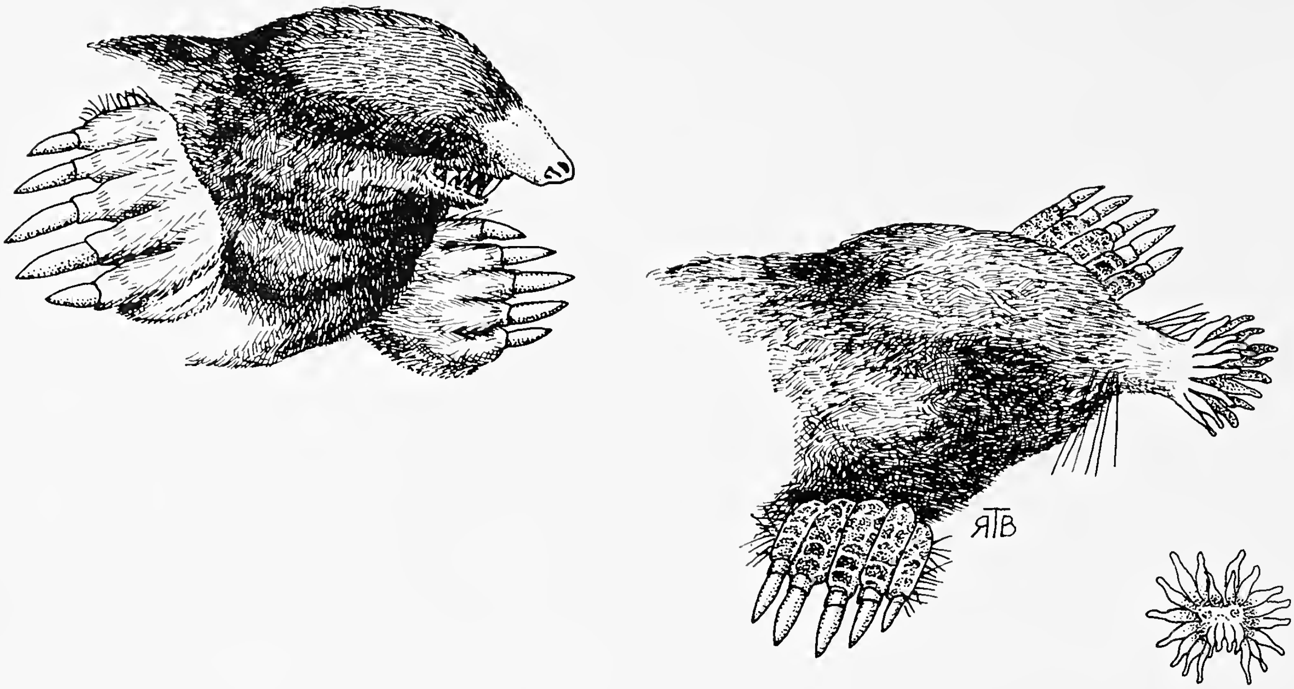

Figure 2. Anterior external comparison of the Eastern mole (*Scalopus aquaticus*) and the Star-nosed mole (*Condylura cristata*); the common name of the latter is based on the 22 fleshy appendages surrounding its nostrils. Illustration R. Brunstetter (in part from Clark 1987). ca 125x.

Systematics and Distribution

Generally, Star-nosed moles are largest in the Northeast and become progressively smaller to the south, reaching their minimum size in the southern Appalachians and the southeastern Coastal Plain. Nevertheless, this variation is not simply clinal, and two races were recognized by Paradiso (1959) and subsequent workers. (A third race, *Condylura cristata nigra* from Nova Scotia, has been synonymized.) Peterson and Yates (1980) described the southern form, *Condylura cristata parva,* in greater detail and identified the following cranial characteristics for separation of this smaller subspecies: shorter, shallower, narrower skull, with most cranial measurements averaging less; greatest length of skull seldom more than 34.0 mm, greatest length of the palate seldom more than 14.4 mm, and depth of skull seldom more than 10.0 mm.

Additionally, *C. c. parva* is smaller in external measurements than the northern *C. c. cristata.* Measurements of specimens from various portions of the range of *C. cristata* are presented in Tables 1 and 2. The lesser measurements of *C. c. parva* are in relation to total body size, and weight, therefore, may be a good indication of subspecific status. Specimens of Star-nosed moles from the northern portion of the species range averaged 48.3 g in weight (N = 13, Van Zyll de Jong 1983), while specimens from the Carolinas for which weights are available averaged 31.6 g (N=13, North Carolina State Museum and Clemson University).

The distribution of *C. cristata* in the Southeast is discontinuous and apparently many local populations are fragmented. While the range in broad terms is well known, it is less well

Table 1. Selective measurements of *Condylura cristata* from the Delmarva peninsula. (* skull broken)

Location	Collection	Cat. No. (sex)	Date	Total Length	Tail	Hind Foot	Skull Length	Interorbital Breadth	Height of Brain Case
Virginia, Accomack Co.	USNM	307428 (♂)	11 June 1958	169	59	25	31.0	6.5	9.5
Maryland, Worcester Co.	NCSM	1815 (♀)	19 April 1973	170	58	22.5	32.0	6.9	9.5
Maryland, Worcester Co.	NCSM	2472 (♂)	29 May 1975	168	59	24.3	31.5	6.4	9.5
Delaware, Kent Co.	NCSM	4938 (♀)	10 Nov. 1985	168	55	25	*	5.9	*

Table 2. Sizes of various geographical samples of Star-nosed moles. Populations 1-3 *C. c. cristata,* 6-7 *C. c. parva,* 4-5 not clear (see text). External and cranial measurements of Delmarva population in Table 1.

Region	TL	TV	HF	Skull Length	Source
1 Canada (N = 73)	190.9 (162-238)	76.8 (64-92)	27.7 (15-32)	33.6 (31.8-35.1) (N = 33)	Van Zyllde Jong 1983
2 Nova Scotia (N = 7)	194.8 (177.0-206.0)	74.3 (70.0-78.0)	--	34.5 (34.1-35.2)	Yates 1978
3 Massachusetts (N = 10)	199.8 (195-208)	78.1 (76-83)	28.4 (27-30)	34.6 (33.4-33.5) (N = 7)	Paradiso 1959
4 W. Pennsylvania (N = 22)	180 (161-191)	69.0 (61.0-76.0)	--	30.0 (32.1-34.3)	Yates 1978
5 District of Columbia (N = 2)	184 (183-185)	65.5 (65-66)	28	33.6 (33.4-33.9)	Paradiso 1969
6 Virginia and West Virginia (N = 6)	-- (160-170)	-- (58-63)	-- (24-25)	-- (30.8-32.0)	Paradiso 1959
7 Carolinas (N = 15)	162.6 (153-180)	57.4 (51-68)	24.2 (23-26)	31.9 (31.6-32.1) (N = 4)	NCSM Clemson University

defined locally because of the secretive nature and apparent low density of Star-nosed moles in the Southeast. South of the Potomac River Basin, the species splits into two populations, one in the Coastal Plain and one in the mountains; so North Carolina has no Piedmont records (Lee et al. 1982), nor does South Carolina. A small, very isolated population is known from the outer Coastal Plain of southern Georgia, where it is confined to portions of Charlton, Chatham, Clinch, and Effingham counties (Laerm et al. 1982). Actually, the absence of *C. cristata* from the Piedmont starts in Maryland and northern Virginia, but this is partly masked by the mole's distribution around the Chesapeake Bay and Potomac River Basin (Fig. 3 and 4).

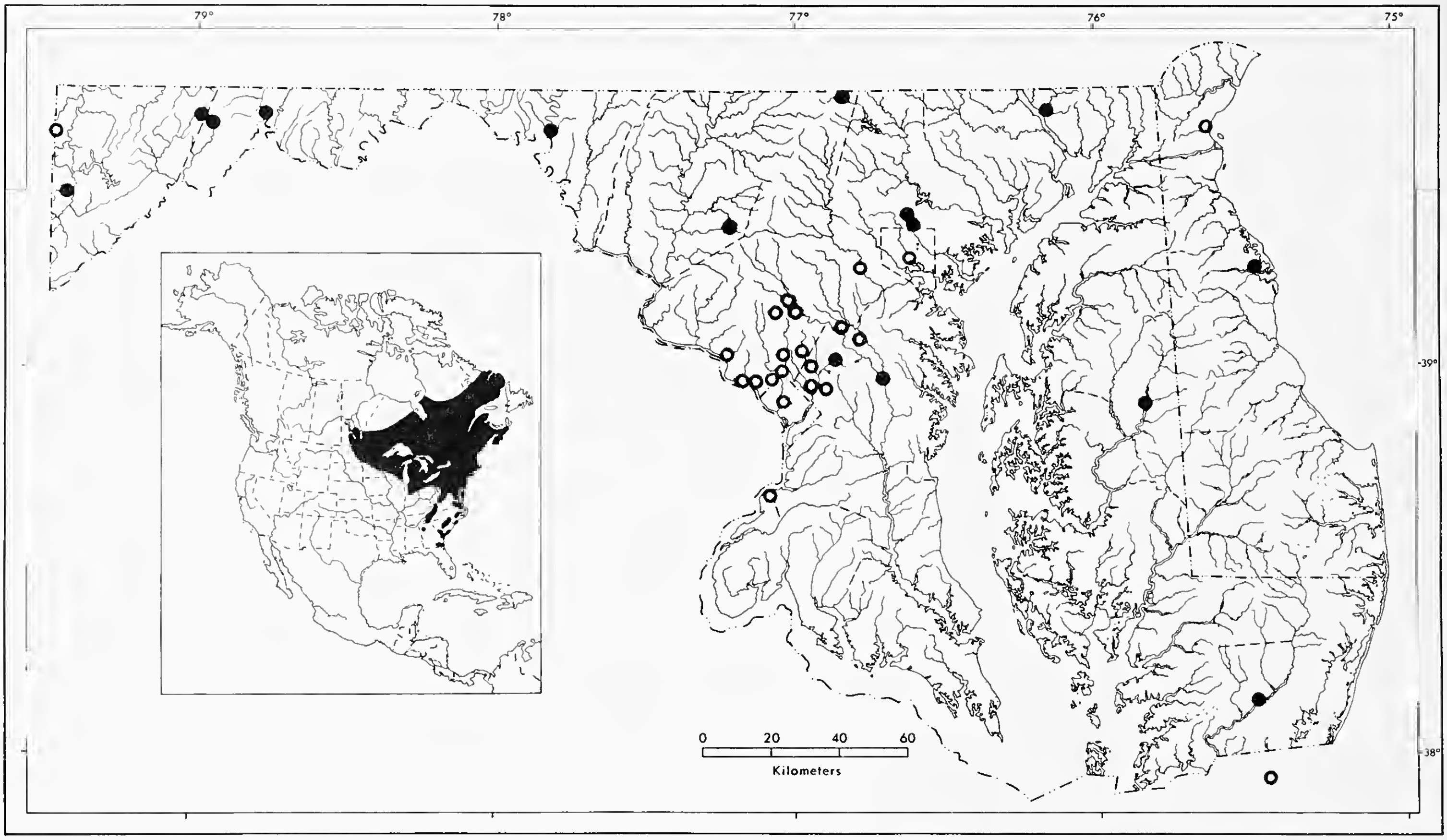

Figure 3. Distribution of *C. cristata* in Maryland and Delaware. Hollow dots show records in Paradiso (1969), others this study. Inset map indicates approximate total range of species.

Early distributional information erroneously indicated that this species occurred uniformly throughout much of the central Atlantic states area (Hamilton 1943), or overlooked the Coastal Plain populations in the Carolinas (Hall and Kelson 1959, Burt and Grossenheider 1964, Hamilton and Whitaker 1979). Authors of state books on Southeastern mammals were confused by these general treatments and assumed that the scattered distributional records from their areas of study simply reflected poor representation in collections, and for the most part they failed to define or limit local distributions (e.g., Golley 1966).

To my knowledge only four specimens (three previously unreported) of *C. cristata* are available from the central and lower Delmarva Peninsula. These are two I found as road kills at Milburn Landing, Worcester County, Maryland (NCSM 1815, 2472), one reported by Paradiso (1959) from 2.3 mi E Wattsville, Accomack County, Virginia (Table 1). A fourth

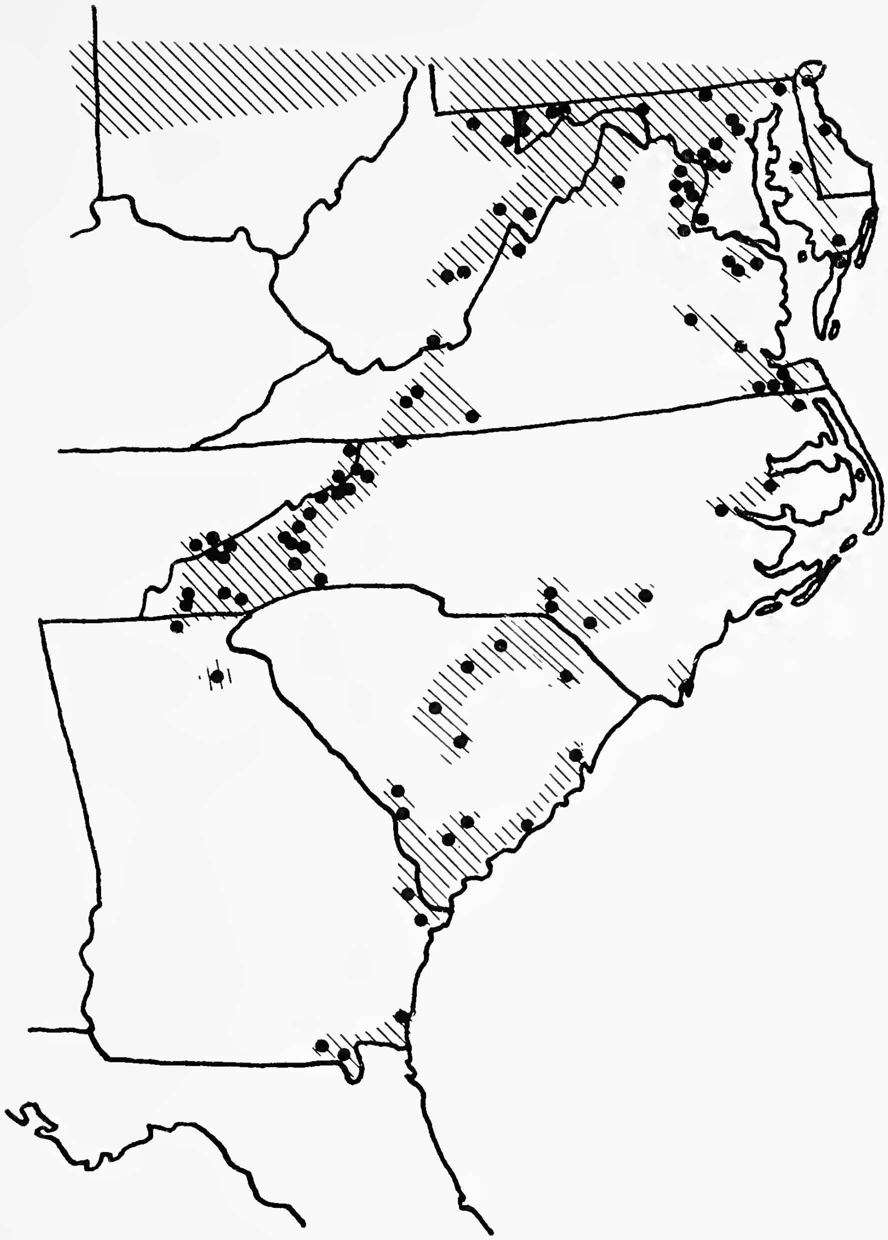

Figure 4. Distribution of *C. cristata* in the southeastern United States based on Paradiso (1959) and this study (Appendix I). Dots represent specific collection localities, shading indicates the apparent distribution of the species in the Southeast.

specimen from Bombay Hook National Wildlife Refuge, Kent Co., Delaware (NCSM 4938) represents the third record from Delaware and the onlv one from that state's Coastal Plain. The two Maryland specimens were found on the same section of a hard-surfaced road leading into the Milburn Landing State Park camping area. One was collected on 19 April 1973, the other on 29 May 1975. Both were found early in the evening on rainy nights. This section of the road is bordered on both sides by dense thickets of Mountain laurel (*Kalmia latifolia*) with a heavy ground cover of leaves and other organic debris. Other plants found immediately adjacent to the site include a canopy and subcanopy of Red maple (*Acer rubrum*), Flowering dogwood (*Cornus florida*), Loblolly pine (*Pinus taeda*), American holly (*Ilex opaca*), Sweet gum (*Liquidambar styraciflua*), and various black oaks (*Quercus* sp.). The ground was nearly void of living plant cover except for scattered clumps of Lady fern (*Athyrium asplenioides*). Within a few meters the higher ground gave way to lower swamp forest. An additional Maryland eastern shore individual from near Denton, Caroline County, was examined by Arnold Norden (pers. comm.), but the specimen has been lost.

The specimen from Accomack County was an immature male, and Paradiso (1959) considered it represenative of *C. c. parva*. The two Worcester County specimens and the Kent County, Delaware, specimen also fall into the size range of *C. c. parva,* and are much smaller than other Maryland *C. c. cristata* as described by Paradiso (1969) or other Maryland material I have examined. Although Maryland, eastern Pennsylvania, and northwestern Virginia lie within an apparent intergradation zone between *C. c. cristata* and *C. c. parva* (Paradiso 1959), the lower Delmarva specimens fit *parva* and are clearly not intergrades. All are smaller, for example, than the measurements provided by Paradiso (1969) for two adults from the District of Columbia (see Table 2). Since the original description of *C. c. parva,* the North Carolina State Museum has accumulated additional material of this race, and the Delmarva specimens are closer in size to North Carolina specimens in our collection than they are to those from latitudes similar to the Delmarva Peninsula collection sites but on the western side of the Chesapeake Bay. Unfortunately, weights are not available for any of the Delmarva material.

Condylura cristata apparently occurs through much of Maryland but is absent from most of southern Maryland (western shore) and is sporadically distributed on the Delmarva Peninsula (Fig. 3). Specimens from Conowingo, Cecil County (NHSM) and Fort Delaware (Paradiso 1959) establish the presence of the species at the heads of the Chesapeake and Delaware bays. A hiatus may occur in the upper Delmarva, so that the Delmarva population is isolated. However, this is problematic because of the secretive nature of *C. cristata* and the scarcity of specimens, and additional specimens from the Central Delmarva would greatly enhance the zoogeographic picture.

As stated previously, south of the greater Chesapeake/Potomac basin *C. cristata* is divided into Appalachian and Coastal Plain populations, and of these, the Coastal Plain one at least is not continuous. For the most part, the Coastal Plain population is restricted to sites around larger swamp areas, such as the Dismal and Okefenokee swamps (Paradiso 1959), within extensive pocosins, and in Carolina bays and associated stream-head forests (Clark et al. 1985; this study, see Appendix). Clark et al. (1985) suggest how such habitats may have become refugia for this and other mammals of northern affinity. In the Carolinas, the species is found inland to the sandhills region (Lee et al. 1982; this study), but this is the only Coastal Plain area south of the Potomac River where this mole is known to occur west to the fall line.

The relative distributions of the races of *C. cristata* have received differing treatments in recent publications. The race *C. c. nigra* of Nova Scotia was considered a synonym by Yates (1978) but was included by Hall (1981) presumably as an oversight. The distributions of *C. c. cristata* and *C. c. parva* presented by Hall (1981) parallel those proposed by Paradiso (1959), while Peterson and Yates (1980) show the range of *C. c. parva* to extend north to the Great Lakes and into portions of Canada. Paradiso (1959) originally defined *parva* as a mole smaller in measurable characters than those applied by Peterson and Yates (1980). (For example the latter authors chose a total cranial length of less than 34.0 mm while Paradiso's largest *parva* had a skull length of 32.2. Also, note the size of individuals in populations 1 to 3 in Table 2, which are clearly *cristata*.) Thus, one authority would recognize all Maryland material as *C. c. cristata*, the other as *C. c. parva*. Paradiso (1959) includes 19 Maryland *Condylura* as specimens he regarded as *C. c. cristata,* although he recognized Maryland as part of a broad zone of intergradation.

Whichever subspecific name one applies to local Star-nosed moles, or even if subspecific determinations are ignored, geographically and ecologically the Delmarva population appears to parallel more closely the fragmented, swamp-margin population of the southeastern Coastal Plain than the more continuously distributed, and more ecologically widespread populations of the northeast and of the southern Appalachians. In measurements it is also more closely allied to the southern coastal populations. It is clear that *C. c. parva* is present in Maryland and Delaware no matter how conservatively one delineates the criteria for this

taxon, and that it ranges over the Delmarva Peninsula at least as far north as Bombay Hook (Fig. 3). The Chesapeake and Delaware Canal probably separates *C. c. cristata* and *C. c. parva* in this region today. The U.S. Fish and Wildlife Service recently identified *C. c. parva* as a category 2 candidate under consideration for listing as Threatened or Endangered (Federal Register, 18 September 1985, Vol. 50:181), apparently in response to its spotty distribution based on literature records. In fact, a committee of specialists on North Carolina mammals recently considered the portion of the *C. c. parva* population in North Carolina as a species of concern (Clark 1987). However, as this study indicates (see Appendix I), there are considerably more published records and collected specimens of this race than recent authors have realized.

Zoogeography

No matter how the subspecific nomenclature is applied, it is apparent that the Star-nosed moles on the lower Delmarva Peninsula have closer affinities with those of the Carolinas and southward than with stocks presently residing to the north or the west. Since the fossil record shows that *C. cristata* has been present both to the north (Pennsylvania) and to the west (Maryland) of the Delmarva since at least the mid-to-late Pleistocene (Guilday 1979), it is interesting that lower Delmarva populations apparently were not derived from those stocks. The following generalized scenario explains the origin of the lower Delmarva populations.

During the early Pleistocene, *Condylura* expanded its distribution southward. While most authors regard Pleistocene dispersal to result from glacial displacement, this is not necessarily the case. Hibbard (1960) postulated that in the late Pleistocene(ca 16,000 years B.P.), a period of climatic equitability existed, in which milder winters and cooler summers prevailed. These conditions allowed northern species to extend farther south, and subtropical ones farther north than they do today. This is supported by evidence from several Southeastern fossil deposits (Holman 1976, 1982; Slaughter 1975) and current relictual faunal assemblages. As Pleistocene conditions worsened, these expanded ranges contracted, leaving disjunct relicts surviving where isolated patches of favorable habitat provided suitable conditions. Frazier (1977), for example, notes that the fossil range of the Round-tailed muskrat (*Neofiber*) extended as far north as the Middle Atlantic States and the Great Plains during the Pleistocene. Today this aquatic mammal is restricted to Florida, with its range contracting from the late Pleistocene to the Recent as conditions became drier and colder. Fossil material shows that *Synaptomys* once ranged south to Gainesville, Florida (22,000 years B.P., Orange Lake IIA, R. Franz, pers. comm.). Clark et al. (1985) noted that the southeastern relict and semi-relict populations of the Bog lemming (*Synaptomys cooperi*), Short-tailed shrew (*Blarina brevicauda*), and Star-nosed mole may survive as a result of cooler refugia provided by pocosin habitats on the southeastern Coastal Plain. In a similar manner frost pocket bogs and the boreal forest of high elevations provided habitat in the southern Appalachians. Combined, these two separate, and quite different geographically, regional refugia account for the presence of this mole in the South since Pleistocene times. Thus, during the Pleistocene, *Condylura* was able to colonize and persist well to the south of its normal distributional limits. On the Coastal Plain the shade of evergreen shrub bogs (pocosins) and evaporative cooling apparently ameliorate extreme high temperatures, allowing *Condylura* to persist.

As dispersal into the South progressed, *Condylura* evolved into a smaller form (Bergman's Rule, Jackson 1915), resulting in what Paradiso (1959) would describe as *C. c. parva*. Warming trends, either from a waning period of climatic equitability or from glacial retreat, restricted and fragmented this mole's distribution, with rising Pleistocene sea levels and outer Coastal Plain water tables further restricting the range. As these disjunct and semi-disjunct populations lost genetic contact with northern populations, small body sizes stabilized. The clinal continuum from Canada to about the Potamac River basin was broken, permitting a

more abrupt change in size to the south. The clinal effect resulting from "Bergman's response" and a possible zone of periodic intergradation mask the extent of divergence, with both apparently contributing to the interpretation of Paradiso (1959) of a broad zone of intergradation extending north through Pennsylvania, Maryland, northern Virginia, and West Virginia. The same phenomena apparently led Yates (1978) and Peterson and Yates (1980) to indicate that *C. c. parva* was found much farther to the north. In actuality, the southern Appalachian population and the northeastern populations of *C. cristata* are much more closely related geographically, and probably genetically, than are those of the Coastal Plain. Thus, one would expect a more clinal distribution in size west and north of the fall line, which, in fact, is what we observe today.

Guilday et al. (1964) noted that the Pleistocene *Condylura* from a cave deposit in Pennsylvania are larger than those found in the area today. Like many other species from the same site, modern size equivalents are restricted to the northern portion of their ranges. Thus, the current size gradient evolved recently or undulates with climatic change.

Returning to the relict Delmarva population, it is likely that it invaded the Delmarva peninsula from the south, with the Dismal Swamp area of Virginia and North Carolina providing the most geographically accessible population. There is some evidence that the present-day Susquehanna River and its drowned river basin, the Chesapeake Bay, once discharged across the central Delmarva, emptying into an area now submerged by Delaware Bay. The northern portion of the Delmarva Peninsula would have been affiliated with southeastern Pennsylvania, while the southern portion was geographically separate and actually connected to Virginia and the Carolinas. These sections of the peninsula would have been separated by the Pleistocene Susquehanna River. Geologic evidence of this is exhibited by buried river channels oriented from east to west across the Delmarva in the vicinity of Salisbury (Weaver and Hansen 1966) and by seismic-reflection profiles that show the Susquehanna River once swinging east of its present location and toward Salisbury (Schubel and Zabawa 1973). This paleochannel was cut during a period of lower sea levels prior to the formation of the modern Chesapeake Bay, as evidenced by a buried Susquehanna River channel at least 195 feet below present sea level, which probably entered the Atlantic Ocean into the Washington Canyon.

Lower Pleistocene sea levels would allow a larger land area and broader corridors of dispersal. A change in the outlet of the Susquehanna River and the development of the Chesapeake Bay would finally isolate faunal populations from the south, and the near absence of suitable habitat in the upper Delmarva would continue to the present the isolation of Star-nosed moles from larger northern stocks. The absence of stocks of *C. cristata* in the central Delmarva Peninsula allowed some local expansion of the species range north of the paleochannel. Since the Chesapeake Bay is only 15,000 years old, such an event is relatively recent in relation to the documented presence of *Condylura* in North America and in terms of Pleistocene zoogeography.

Furthermore, it is possible that *Condylura* did not occupy the Delmarva Peninsula during the Wisconsin maximum. Wynn (1986) suggested this was the case for Red-backed salamanders (*Plethodon cinereus*) on the Delmarva, and this may account, in part, for the generally impoverished and unevenly distributed salamander fauna of the present-day Delmarva. Similar Pleistocene factors would likely govern local distribution and dispersal of both Star-nosed moles and Red-backed salamanders.

This proposed sequence of events needs more detailed support from geological scholars, but biological evidence for this, or at least a scenario that would provide a similar end result, is quite strong. This zoogeographic situation is well illustrated by the Meadow vole, *Microtus pennsylvanicus nigrans*, a race confined to the lower Delmarva (north to Cambridge,

Dorchester County, Paradiso 1969), the lower western shore of Maryland (Calvert County, Paradiso 1969), and the Dismal Swamp area of Virginia and North Carolina (south to Dare County, Lee et al. 1980). This distribution is indicative of a past connection between these three land masses. A southern race of the White-footed mouse, *Peromyscus leucopus leucopus*, also is found in the lower Delmarva, but not elsewhere north of the Potomac River (Hall 1981). A similar pattern of lower Delmarva relicts is also apparent in several reptiles and amphibians (e.g. *Gastrophryne carolinensis, Natrix erythrogaster, Diadiphis punctatus, Agkistrodon contortrix* [Harris 1975, Tobey 1985]), various other animals, and certain plants.

Wynn (1986) presented a well-developed argument for separate invasions of Red-backed salamanders from both the north and south. He believed that these invasions took place about 14,000 years BP, corresponding closely with the time tables suggested here. Many other faunal elements also suggest an avenue of dispersal across an area that is presently the lower Chesapeake Bay. This overview of time frames and sampling of supporting zoogeographic evidence for this proposed lower Delmarva/Carolinian connection will be developed more fully in a subsequent publication.

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Appendix I: Additional Southeastern site, literature, and specimen records of *Condylura cristata*, not included by Paradiso (1959, 1969).

DELAWARE: *New Castle Co.*, Delaware City (US National Museum); *Kent Co.*, Bombay Hook National Wildlife Refuge, Finis Pool, 10 Nov. 1985, M. J. Pohlman (NC State Museum).

MARYLAND: *Allegany Co.*, Cumberland, 3 July 1978, M. Valentine (Frostburg State Univ.); Frostburg, 22 June 1977, W. Yoder (Frostburg State Univ.); *Baltimore Co.*, Towson, 1959, D.S. Lee; Happy Hallow Road, July 1962, D. S. Lee; *Baltimore City*, near boat lake in Druid Hill Park October 1978, O. Lugger (Md. Acad. Sci. in Fisher 1895); *Caroline Co.*, Chappel Branch, 2 mi W Denton, June 1981, Harley Speir; *Cecil Co.*, Conowingo Dam, May 1948, R. Simmons (NHSM); *Frederick Co.*, New Market, 28 May 1979, H. H. Hopkins (Fisher 1895); *Carrol Co.*, Lineburrow, 30 June 1973, J. Worthley; *Garrett Co.*, Swallow Falls State Park rock face at Muddy Creek Falls, May 1974, D. S. Lee (photo record at NCSM); 7 mi W, 3 mi S Frostburg, 19 April 1982, G. Broadwater (Frostburg State Univ, not catalogued); *Prince Georges Co.*, Route 301 ca 4 mi S Priest Bridge, August 1947, R. Mansueti and T. Oler (NCSM); Little Paint Branch N end College Park, A. Norden, 19 May 1984; *Worcester Co.*, Milburn Landing State Park, 19 April 1973, 29 May 1975, D. S. Lee (NCSM).

DISTRICT OF COLUMBIA: Brightwood (USNM), Brookland (USNM), "Washington" (USNM).

WEST VIRGINIA: *Greenbrier Co.*, 4.2 mi NE Richwood (McKeever 1954); *Monogalia Co.*, Decker's Creek (in McKeever 1954); *Monroe Co.*, nr Red Sulphur Springs (Audubon and Bachman 1851); *Preston Co.*, 1 mi. E Terra Alta (Carnegie Museum); Lake Terra Alta, 15 June 1950 (Barbour 1951); *Pendeleton Co.*, Big Run (in McKeever 1954); *Randolph Co.*, nr Osceola (in McKeever 1954); *Pocahontas Co.*, Cranberry Glades (USNM).

VIRGINIA: *Fairfax Co.*, Pine Ridge (USNM); Falls Church (Bailey 1946); *Henrico Co.* Univ. of Richmond Campus (Bailey 1946); *Highlands Co.* (Handley and Patton 1947); *Norfolk Co.*, Dismal Swamp, May 1934 (Bailey 1946); Wallaceton, April 1896 (USNM); *Nansemond Co.*, Lake Drummond, May 1896 (USNM); *Patrick Co.*, 5 mi N of Stewart (Handley and Patton 1947); *Prince William Co.*, 4 mi. SE Manassas; *Richmond Co.*, Nayloss (Bailey 1946); *Surry Co.*, nr Scotland, 4 mi NE of Surry (Handley 1978); *Wythe Co.*, New River Valley, Max Meadows (Bailey 1946); *Loudoun Co.* (Handley 1978); *Prince William Co.* (Handley 1978); Richmond Co. (Hall 1981); *Stafford Co.* (Handley 1978); Warren Co. (Handley 1978).

NORTH CAROLINA: "Mountains near the border of South Carolina" (Audubon and Bachman 1851); *Alleghany Co.*, New River at Sparta, 30 May 1968, H. M. Tyus (NCSM); *Avery Co.*, Elk Park (NCSM records); 2.6 miles NNE of Heaton (Auburn University); ¾ mi. SE Linville, 24 July 1984, D. S. Lee and P. Kumhyr (NCSM); *Buncombe Co.*, Asheville (U. Mich. Mus. Zool.); Biltmore (Museum Comparative Zoology); Weaverville, 6 February 1896, Mrs. J. S. Cairns (NCSM records); Swannanoa about 20 April 1931, C. S. Clapp (NCSM records); *Clay Co.*,

Hayesville, 3 August 1947, R. G. Vick (NCSM records); *Currituck Co.* (in Clark 1987), Moyock (in digestive tract of a mink obtained from fur dealer, Wilson 1954); *Cherokee Co.*, Topton, 13 May 1934, E. B. King (Brimley 1944-46); *Green Co.*, pre-1950 (Clark et al. 1985); *Henderson Co.*, Hoopers Creek Valley nr Fletchers, 8 October 1974, B. Sanders (NCSM); *Hoke Co.*, McCain (Clark et al. 1985); *Macon Co.*, Highlands, 1908, H. C. Habison (Brimley 1944-46); *Moore Co.*, West End, burrows and mounds of *Condylura*, 1980, D. S. Lee; *New Hanover Co.*, nr Carolina Beach, 7 June 1959, 16 November 1956, G. Trejembo (NCSM); *Macon Co.*, Highlands, May 1908 (Brimley 1944-46); *Mitchell Co.*, Magnetic City, 1892 or 1893 (Brimley 1905); Roan Mountain "N.C./Tenn. Line" (True 1896); *Pitt Co.*, no exact locality (NCSM records); *Polk Co.*, Green River Valley nr Saluda, 28 May 1974, G. G. Shaw and M. Bradley (NCSM); *Robeson Co.*, nr Lumberton, December 1943, A. M. Ivey (Brimley 1944-46); *Richmond Co.*, 3.7 mi. NE Hoffman, 18 May 1980, A. L. Braswell (NCSM); *Scotland Co.*, Laurinburg, 12 April 1975, R. B. Julian (NCSM); *Swain Co.*, Kephast Prong Hatchery, Oct. 1934; Great Smoky Mt. National Park, Deep Creek, 1934 (Linzey and Linzey 1971); Smokemont, June 1943 (Linzey and Linzey 1971); *Watauga Co.*, Boone, 19 May 1918 (Brimley 1944-46); Blowing Rock (Wake Forest University); *Yancey Co.*, Burnsville, 3 Feb. 1976 (NCSM records).

SOUTH CAROLINA: Recorded as early as 1848 from state without supporting evidence; "Upper South Carolina" (Hall and Kelson 1959 assigned this record to the mountain area of the western portion of the state, but original source is probably from Burnett [1851] who wrote on the fauna of the Pine Barrens of Upper South Carolina. Thus record is for the Aiken County area); *Aiken Co.*, Aiken (Char. Mus. records); *Calhoun Co.*, St. Matthews, 20 Sept. 1928, E. Sanders (Char. Mus. Records); *Charleston Co.*, (Golley 1966), nr Charleston 1917-19 (Char. Mus. records); *Chesterfield Co.*, taken from the stomach of a Largemouth bass (ca 392 mm) caught in Black Creek near Hartsville, 15 April 1975 (Char. Mus. records); *Colleton Co.*, Walterboro, 2 Jan. 1948 (News and Courier, 8 Jan. 1948); *Barnwell Co.* (all Savannah River Plant), Rainbow Bay, 26 April 1979, 8 May 1980, 1 Nov. 1977, 1 June 1981, J. Caldwell (Clemson University); "S" Bay, 8 May 1980, J. Caldwell (Clemson Univ.); Stell Creek, 27 May 1981, J. Caldwell (Clemson Univ.), 1 June 1979, "RLB" (Clemson Univ.); *Georgetown Co.*, Georgetown, 3 April 1954 (Grimm 1955); *Hampton Co.*, I 95 nr Yemassee, burrows and mounds of *Condylura*, Sept. 1978, D. S. Lee; *Kershaw Co.*, 28 Jan. 1941, R. E. Ware (Char. Mus. Records, Brimley 1944-46); *Marion Co.* (Golley 1966); *Richland Co.* (Golley 1966); Congaree Swamp, April/May 1984, (Clemson Univ.).

TENNESSEE: *Blount Co.*, Little River Road, Sept. 1950 (Linzey and Linzey 1971); *Carter Co.*, Roan Mountain at state line (Wake Forest University, Tuttle 1968); *Sevier Co.*, Appalachian Trail nr Charlies Bunion, 1961, 1964 (Linzey and Linzey 1971); Appalachian Trail between Newfound Gap and Indian Gap, no date (Linzey and Linzey 1971); *Monroe Co.*, Cherokee National Forest (in Yates 1978).

GEORGIA: *Chatham Co.*; *Clinch Co.*, 15 mi NE Fargo on Hwy 177, 10 Sept. 1966 (Univ. of Ga.); *Jackson Co.*; *Union Co.* (in Laerm et al. 1982).

A Blue Catfish (*Ictalurus furcatus*) From the Potomac River

Marta F. Nammack and Jean M. Fulton

The Blue catfish, *Ictalurus furcatus*, is native to the Mississippi River basin and drainages of the Gulf slope (Burkehead et al. 1980). The Virginia Commission of Game and Inland Fisheries has sucessfully stocked Blue catfish in the James and Rappahannock rivers (Burkehead et al. 1980 and B. Kriete, pers. comm.). They have also been reported from the Maryland portion of the Potomac River (Lee et al. 1981) based on several old records. These historic reports from the Potomac River have been anecdotal or were cases of probable misidentification (Burkehead et al. 1980) and there have been no recent records despite intensive survey (A. Norden, pers. comm.). This note reports the first verifiable record for this species in the Potomac River.

A Blue catfish was captured by us with a 7.6 cm stretch mesh gill net on August 7, 1987, in the Potomac River outside the mouth of the Anacostia River. This specimen was a male that weighed 345 gm and measured 285 mm (fork length). It was deposited in our permanent reference collection.

The origin of this specimen is not certain. Burke and Brittle lakes, in Fairfax and Fauquier Counties, Virginia, which drain into the Potomac River, were stocked with Blue catfish in 1981, 1983, and 1985, and they will most likely be stocked again in 1987 (E. Steinkoenig, pers. comm.). It is possible that Blue catfish escaped into the Potomac River from these lakes during high water conditions. Alternatively, they may have originated in the Rappahannock River. A recreational fisherman may have introduced specimens into the Potomac River, or, less likely, they may have entered the Potomac via the Chesapeake Bay during a particularly rainy year when salinities were lower. Regardless of its origin, it will be interesting to see if a viable population of *I. furcatus* has been established in this area.

The authors would like to express their appreciation to Dr. L. Knapp for verification of the specimen. This specimen was captured while conducting a survey partially funded by NOAA Grant #NA85EA-H-00027.

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Notes On Some Recent Plant Collections From Cecil County, Maryland

Donn Redman

Recently, while making plant collections for the herbarium at Towson State University, I noted the following interesting records for Cecil County. Each of these species is rare or uncommon in Maryland and none were reported from Cecil County by Witman (1954). Vouchers have been deposited in the herbarium at Towson State University (BALT).

Ellisea nyctelea L., Baby Blue-eyes

This member of the Hydrophyllaceae occurs along the Potomac River in Montgomery and Allegany Counties (Brown and Brown 1984). It also occurred historically at Baldfrier in northwest Cecil County (Tatnall 1946), where the plants have been extirpated. Outside of Maryland, *E. nyctelea*, is found along the Delaware River, the Potomac River in West Virginia, north of Maryland along the Susquehanna River, and in dry soils of the northern Great Plains. I recently discovered two small colonies of this species in a shady alluvial woods just north of the Fall Line in the Port Deposit area (Redman 4276, BALT).

Hieracium marianum Willd. (*H. gronovii* x *venosum*), Maryland Hawkweed

Despite the common name, this hybrid species of the Asteraceae is known from Maryland only in Kent County (Tatnall 1946, Brown and Brown 1984) but it ranges widely north of us, south to Alabama and Florida, and west to Ohio. I recently located a small colony in a dry woods bordering Aiken Swamp (Redman 4244, BALT).

Boltonia asteroides (L.) L'Her., Star Boltonia

This Asteraceous species occurs infrequently on the Lower Eastern Shore and was collected in the Conowingo area on a rocky island sixty-five years ago (Tatnall 1946, Brown and Brown 1984). It is rare throughout its range from Connecticut to Florida and west to Minnesota, Nebraska, and Louisiana. I recently located three plants of this species in the floodplain of the Susquehanna River south of the Conowingo Dam (Redman 4405, BALT).

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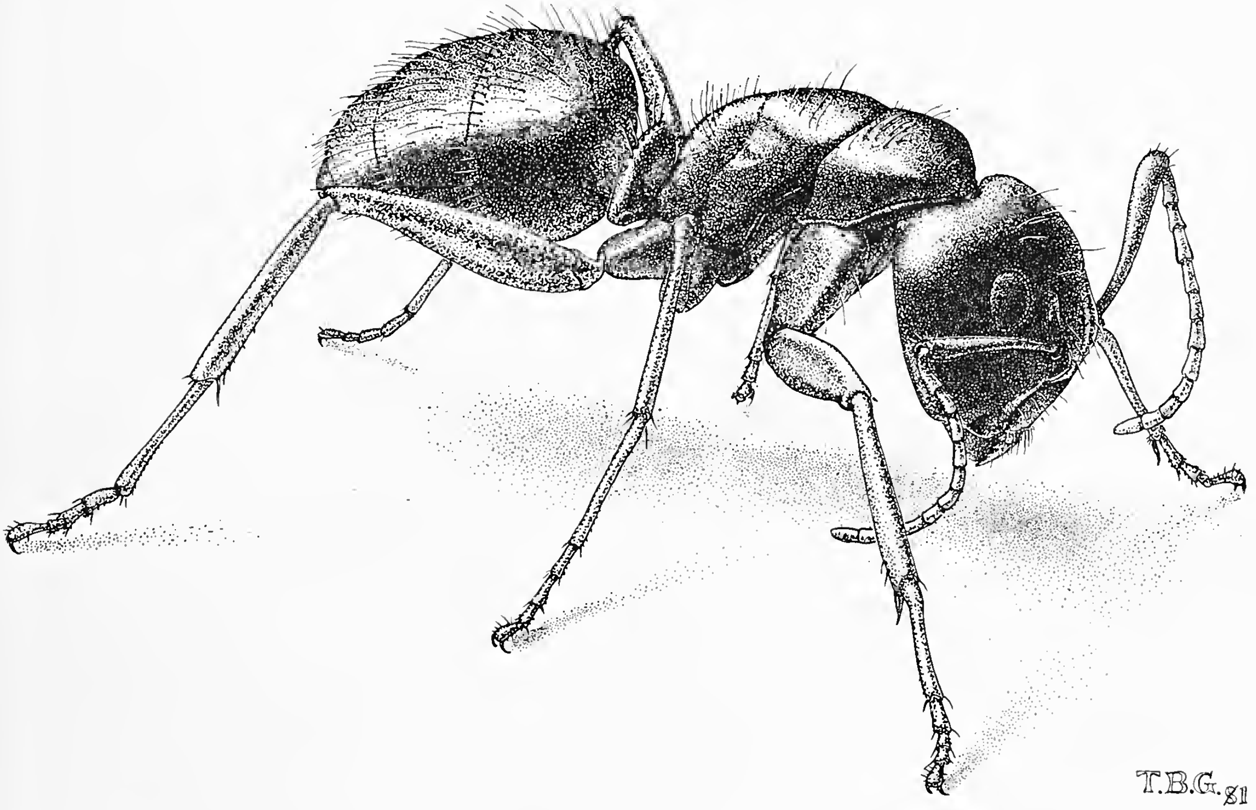

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Arnold W. Norden, Editor

Cover Illustration: Camponotus pennsylvanicus is one of the most common large carpenter ants in the Chesapeake Bay Region. Original drawing by Theophilus B. Griswold, provided by John F. Lynch (Smithsonian Institution).

An Annotated Checklist and Key to the Species of Ants (Hymenoptera: Formicidae) of the Chesapeake Bay Region

James F. Lynch

INTRODUCTION

This checklist and key are intended for use by biologists interested in behavioral and ecological studies of ants in the Middle Atlantic region of the U. S. In this region, as elsewhere, such research often is hampered by the lack of suitably focused and up-to-date taxonomic references, with the result that field biologists find themselves completely dependent on identifications provided by taxonomic experts. The only existing species key that covers the ants of the Chesapeake Bay Region is the excellent monograph on North American ants by Creighton (1950). Unfortunately for the local student of ant biology, Creighton's seminal work suffers both from its broad geographic scope (585 species and subspecies treated) and from the fact that a number of important taxonomic revisions have been undertaken in the past 38 years. Nevertheless, Creighton's book remains the most important basic reference for serious students of North American ants, and most of the taxonomic keys included in the present work are subsets of the more extensive keys constructed by Creighton. However, I also have accommodated the following revisionary studies: Brown (1953) - Smithistruma; Brown (1958) - Proceratium; Buren (1968a) - Crematogaster; Francoeur (1973) - Formica (fusca group); Gregg (1958) - Pheidole; Smith (1957) - Stenamma; Taylor (1967) - Ponera and Hypoponera; Trager (1984) - Paratrechina; Wilson (1955) - Lasius; Wing (1968) - Acanthomyops. Smith (1979) has summarized the current (as of 1979) taxonomic status and geographic distribution of North American ants, including those treated here.

Scope

The present work focuses on the identification of the approximately 100 ant species known or expected to occur in the coastal plain region of Maryland, Delaware, and Virginia. The keys should prove useful for ant species encountered along the Atlantic Coastal Plain north and south of the Chesapeake Bay region, but less so in the Piedmont and Appalachian provinces to the west where many species of basically northern distribution occur. I have collected approximately 70 of the species treated here, most of them at the Smithsonian Environmental Research Center (SERC), on Maryland's western shore of Chesapeake Bay (see below).

I have included keys to the workers of all subfamilies, genera, and species of ants that actually or potentially occur in the study area. The author of each species name is indicated in the brief ecological discussions that follow each generic key. Only species that I have observed in the field are discussed individually, and those that have been collected at the SERC site are marked by an asterisk.

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Table 1. A list of the 102 species of ants known or expected to occur in the Chesapeake Bay region. The species marked with an asterisk (*) have been collected at the Smithsonian Environmental Research Center, 5 km S Edgewater, Anne Arundel Co., Maryland.

Subfamily Ponerinae (7 species)

1. Amblyopone pallipes*
2. Proceratium croceum*
3. Proceratium pergandei
4. Proceratium silaceum
5. Ponera pennsylvanica*
6. Hypoponera opaciceps*
7. Hypoponera opacior

Subfamily Myrmicinae (53 species)

1. Anergates atratulus
2. Smithistruma abdita
3. Smithistruma clypeata
4. Smithistruma creightoni
5. Smithistruma dietrichi*
6. Smithistruma missouriensis
7. Smithistruma ohioensis*
8. Smithistruma ornata*
9. Smithistruma pergandei
10. Smithistruma pilinasis
11. Smithistruma pulchella
12. Smithistruma reflexa
13. Smithistruma rostrata*
14. Crematagaster ashmeadi
15. Crematogaster cerasi*
16. Crematogaster clara*
17. Crematogaster lineolata*
18. Crematogaster pilosa*
19. Solenopsis carolinensis
20. Solenopsis molesta*
21. Solenopsis texana
22. Trachymyrmex septentrionalis
23. Harpagoxenus americanus*
24. Leptothorax ambiguus*
25. Leptothorax curvispinosus*
26. Leptothorax longispinosus*
27. Leptothorax pergandei*

Subfamily Myrmicinae (cont'd)

28. Leptothorax schaumi*
29. Myrmica americana*
30. Myrmica emeryana
31. Myrmica lobicornis
32. Myrmica pinetorum
33. Myrmica punctiventris*
34. Myrmecina americana*
35. Tetramorium caespitum*
36. Monomorium minimum*
37. Monomorium pergandei
38. Monomorium viridum
39. Pheidole bicarinata*
40. Pheidole davisi*
41. Pheidole dentata*
42. Pheidole morrisi*
43. Pheidole pilifera*
44. Stenamma brevicorne*
45. Stenamma diecki*
46. Stenamma impar*
47. Stenamma schmitti*
48. Aphaenogaster fulva*
49. Aphaenogaster lamellidens*
50. Aphaenogaster mariae
51. Aphaenogaster rudis*
52. Aphaenogaster tennesseensis*
53. Aphaenogaster treatae*

Subfamily Dolichoderinae (7 species)

1. Dolichoderus mariae
2. Dolichoderus plagiatus*
3. Dolichoderus pustulatus*
4. Dolichoderus taschenbergi
5. Iridomyrmex humilis
6. Iridomyrmex pruinosus*
7. Tapinoma sessile*

Table 1 (cont'd)

Subfamily Formicinae (35 species)

1. *Brachymyrmex depilis**
2. *Camponotus* (*Cam.*) *americanus**
3. *Camponotus* (*Cam.*) *ferrugineus**
4. *Camponotus* (*Cam.*) *novaeboracensis*
5. *Camponotus* (*Cam.*) *pennsylvanicus**
6. *Camponotus* (*Tae.*) *castaneus**
7. *Camponotus* (*Myr.*) *caryae*
8. *Camponotus* (*Myr.*) *nearcticus**
9. *Camponotus* (*Myr.*) *subbarbatus**
10. *Camponotus* (*Col.*) *impressus**
11. *Paratrechina faisonensis**
12. *Paratrechina parvula*
13. *Paratrechina pubens*
14. *Paratrechina vividula*
15. *Prenolepis imparis**
16. *Lasius alienus**
17. *Lasius flavus*

Subfamily Formicinae (cont'd)

18. *Lasius neoniger**
19. *Lasius umbratus**
20. *Acanthomyops claviger**
21. *Acanthomyops interjectus*
22. *Acanthomyops latipes**
23. *Acanthomyops murphyi*
24. *Acanthomyops subglaber*
25. *Formica difficilis*
26. *Formica exsectoides*
27. *Formica integra**
28. *Formica obscuriventris*
29. *Formica pallidefulva**
30. *Formica pergandei*
31. *Formica rubicunda*
32. *Formica schaufussi**
33. *Formica subintegra**
34. *Formica subsericea**
35. *Polyergus lucidus**

Because many of the anatomical terms used in the taxonomic keys will be unfamiliar to non-specialists, an illustrated glossary is included

The SERC Study Area

Most of my ecological research on ants has been conducted at the 1,000 ha SERC site, located approximately 10 km (air line) south of Annapolis, Anne Arundel County, Maryland. The SERC reserve includes cropland, pasture, old-fields, young woodlands, and mature upland and bottomland deciduous forest. I have collected 60 species of ants at this site since I began my field research there in 1975. The two most intensively studied areas are (1) a stand of mature upland hardwood forest dominated by American beech (*Fagus grandifolia*), oaks (*Quercus* spp.), hickories (*Carya* spp.), and Tulip poplar (*Liriodendron tulipifera*), and (2) an "old-field" that was abandoned from agriculture about 1971, and is presently undergoing secondary succession. The vegetation of both sites is described in Lynch et al. (1980, 1988) and Lynch (1981). At these two sites, and to a lesser extent in other habitats at SERC, ants have been quantitatively sampled and observed at all hours of day and night, during all seasons of the year, and in several vertical strata (soil, litter, surface, arboreal vegetation).

Acknowledgements

I take this opportunity to extend special thanks to Roy R. Snelling of the Natural History Museum of Los Angeles County for his invaluable taxonomic assistance over the past 12 years. The following people contributed significantly to the field studies that were the impetus for this paper: Edward Balinsky, Brenda Davis, Alexander Johnson, Patricia Mehlhop, Warren Steiner, and Stephen Vail.

Key to the Subfamilies of Ants of the Chesapeake Bay Region

(Source: Creighton 1950)

1. Gaster with distinct constriction between the first and second segments; pedicel one segmented (Fig. 1a) ....Ponerinae

   Gaster without such a constriction; pedicel with one or two segments 2

2. Abdominal pedicel consisting of two segments (Fig. 1b) .....Myrmicinae

   Abdominal pedicel consisting of one segment (Fig 1c, 1d) 3

3. Cloacal orifice slit-like, not surrounded by a fringe of hairs (Fig. 4a) ....Dolichoderinae

   Cloacal orifice distinctly circular and usually surrounded by a fringe of hairs (Fig. 4c) ....Formicinae

Note: Representatives of two mainly tropical and subtropical subfamilies (Ecitoninae and Pseudomyrmecinae) range northward along the Atlantic coast nearly to the Chesapeake Bay region.

....

Subfamily PONERINAE

Four genera of this primitive subfamily occur in the study area. All are timid, mainly subterranean forms with reduced vision and with predatory habits.

Key to the Genera of the Subfamily Ponerinae Known or Expected in the Chesapeake Bay Region

(Sources: Creighton 1950, Taylor 1967)

1. Anterior border of the clypeus denticulate; mandibles with a row of coarse, bidenticulate teeth (length 5.0 mm or more) ....<u>Amblyopone</u>*

   Anterior border of clypeus variously shaped but never denticulate; mandibular teeth, when present, single (length 4.0 mm or less) 2

2. Thoracic dorsum without sutures, or at most a shallow impression at the point at which the sutures should be (apex of the gaster directed ventrally or anteroventrally when the major axis of the gaster is in line with that of the thorax) ....<u>Proceratium</u>*

   Thoracic dorsum with promesonotal and mesoepinotal suture present ...3

3. Posteroventral corner of subpetiolar process composed of 2 separate teeth, situated side by side; anterior of subpetiolar process with 2 distinct circular or oval fenestra ....<u>Ponera</u>*

Subpetiolar process a simple lobe; never with fenestra or paired posterolateral teeth .... *Hypoponera**

(* genus occurs at SERC site)

Genus *Amblyopone* Erichson

This primitive cosmopolitan genus (formerly known as *Stigmatomma* Roger) has its center of diversity at tropical and subtropical latitudes. One of the several North American species occurs in the Chesapeake Bay region.

1. *Amblyopone pallipes* (Haldeman)

Although this species is fairly common in moist woodlands at SERC, it has never been observed active at the surface. A few individuals have been collected under logs and other surface objects, but most have been taken in samples of soil or leaf litter. *A. pallipes* forms small colonies of 10-50 workers, and is morphologically specialized for feeding on geophilid centipedes. It ranges throughout forested areas of eastern North America.

Genus *Proceratium* Roger

As presently constituted (Brown 1958), this genus includes species formerly assigned to the genus *Sysphincta* Roger. These are inconspicuous, apparently rare ants that place their small colonies in the soil or inside rotted logs. They are thought to feed mainly on arthropod eggs.

Key to the Species of *Proceratium* Known or Expected in the Chesapeake Bay Region

(Sources: Creighton 1950, Brown 1958, Snelling 1967)

1. Petiole nodiform, low and much rounded above; clypeus with a narrow median lobe which projects strongly beyond the remainder of the anterior border .... *pergandei*

   Petiole erect and scale-like, the front and rear faces flattened; anterior border of the clypeus not projecting in the middle 2

2. Length 3.75 - 4 mm; node of petiole seen in profile thick and blunt above, the base very little thicker than the crest; epinotal teeth prominent .... *croceum**

   Length 2.75 mm or less; node of petiole in profile slender, the base notably thicker than the crest; epinotum without distinct spines *silaceum*

1. *Proceratium croceum* (Roger)

Two workers of this secretive species have been collected in leaf litter from mature deciduous forest. The main range of the species is the

southeastern U.S., north to Virginia; the present SERC record appears to be the first for Maryland.

Genus *Ponera* Latreille

According to the generic revision of Taylor (1967), *Ponera* is an essentially tropical group, with only a single widespread North American species. Members of the genus are small, timid ants that forage mostly below the ground surface for arthropods.

1. *Ponera pennsylvanica* (Buckley)

This elongate, dark brown species is inconspicuous, but is virtually ubiquitous in the litter and soil zones at SERC. Although colonies contain fewer than 100 workers, the density of colonies probably exceeds that of any other local ant species. Individual workers are occasionally observed slowly moving over the ground, but most foraging apparently takes place in the litter and below the ground surface. The species ranges throughout the eastern deciduous forest region of North America, from Nova Scotia and southern Ontario to northern Florida and the Gulf states. A few isolated localities are known as far west as Utah, Colorado, and New Mexico.

Genus *Hypoponera* Santschi

Hypoponera, previously considered a subgenus of *Ponera*, was accorded full generic status by Taylor (1967). Like *Ponera*, *Hypoponera* contains small, elongate, timid species, most of which occur in tropical and subtropical areas. The local members of the two genera cannot be distinguished in the field, but Taylor's (1967) diagnostic characters are fully adequate if specimens can be examined microscopically.

Key to the Species of *Hypoponera* Known or Expected in the Chesapeake Bay Region

(Sources: Creighton 1950, Taylor 1967)

1. Petiole when viewed in lateral profile slender, subtriangular (that is, narrower dorsally than ventrally) .... *opacior*

   Petiole when viewed in lateral profile robust, subrectangular (that is, approximately as wide dorsally as ventrally) .... *opaciceps**

1. *Hypoponera opaciceps* (Mayr)

This species is much less common than *Ponera pennsylvanica* at SERC, and appears to be restricted to brushy old-fields and other relatively open habitats. Another member of this basically southern genus (*H. opacior*) occurs as far north as Virginia, but has not been found at SERC. *H. opaciceps*, on the other hand, was previously thought to be restricted to areas south of South Carolina, and the present SERC records constitute a substantial range extension.

Subfamily MYRMICINAE

The Myrmicinae are by far the most structurally and ecologically diverse of the eight recognized subfamilies of living ants (see Brown 1973 for a list of the genera of Formicidae). A total of 15 myrmicine genera are known to occur in the Chesapeake Bay region, of which 13 have been collected at the SERC site. Of the two exceptional genera, one (*Anergates*) is a bizarre workerless parasite of *Tetramorium caespitum*, and may eventually be discovered at SERC. The second (*Trachymyrmex*) is apparently restricted to loose, sandy soils along the Atlantic coast in the mid-Atlantic region, and does not occur in the heavier soils typical of the western shore of Chesapeake Bay.

Most local myrmicines feed on a combination of scavenged arthropods and carbohydrate-rich liquids, especially "honeydew" produced by aphids, coccids, and other homopterous insects. However, a few genera (e.g., *Smithistruma*) are highly specialized hunters of live insect prey, and one species (*Trachymyrmex septentrionalis*) feeds on fungi that it cultivates in subterranean fungus gardens similar to those of the related tropical leaf-cutting ants of the genus *Atta*. A few local species of Myrmicines (e.g., *Aphaenogaster tennesseensis*, *Harpagoxenus americanus*) are parasitic on other myrmicine species for part or all of the life cycle.

Key to the Genera of the Subfamily Myrmicinae Known or Expected in the Chesapeake Bay Region

(Sources: Smith 1947; Creighton 1950)

1. Workers absent .... *Anergates*

   Workers present 2

2. Antennae with 6 segments .... *Smithistruma**

   Antennae with more than 6 segments 3

3. Postpetiole attached to the dorsal surface of the base of the gaster; gaster flattened dorsally, but much more convex ventrally, and (in dorsal view) heart-shaped with an acute tip (antenna 11-segmented) *Crematogaster**

   Postpetiole attached to anterior end of gaster; gaster about equally convex above and below, the tip (in dorsal view) not notably acute ..4

4. Antennae with 10 segments, the last 2 forming a very distinct club; (epinotum without spines) .... *Solenopsis**

   Antennae with more than 10 segments 5

5. Antennae with 11 segments 6

   Antennae with 12 segments 8

6. Thoracic dorsum without spines, projecting bosses or ridges; spines or teeth, when present, confined to the epinotum 7

Thoracic dorsum with spines, projecting bosses, and ridges; antennal fossae bounded by a delicate carina which runs diagonally inward from the insertion of the mandible past the medial border of the eye
Trachymyrmex

7. Frontal carinae extending rearward at least two-thirds of the distance to the posterior corners of the head, each carina bordering an elongate shallow depression (antennal scrobe) for the reception of the antennal scape, the latter much flattened ....Harpagoxenus*

Frontal carinae short, no antennal scrobes present, the antennal scape not flattened ....Leptothorax (in part)*

8. Middle and hind tibial spurs very finely pectinate, the teeth distinct and regular but usually too small to show unless high magnification is used (promesonotal suture absent on the dorsum) ....Myrmica*

Spurs of middle and hind tibia simple or absent 9

9. Petiole subcylindrical, without a distinct node above; 2 pairs of spines on epinotum ....Myrmecina*

Petiole with a distinct node, the anterior peduncle distinct even when short; at most one pair of epinotal spines 10

10. Lateral portions of the clypeus raised behind into a narrow ridge or carina which forms an abrupt semi-circular boundary at the front of the antennal fossae ....Tetramorium*

Clypeus not as above; antennal fossae opening onto the clypeus without a boundary 11

11. Epinotum unarmed, the basal face at the same level as the dorsum of the mesonotum ....Monomorium*

Epinotum usually armed with spines or teeth, but if unarmed the basal face is distinctly below the level of the dorsum of the mesonotum ..12

12. Worker caste strongly dimorphic, the major worker with a disproportionately large head ....Pheidole*

Worker caste monomorphic, or at most weakly polymorphic; head of larger workers similar in proportion to that of smaller workers 13

13. Thoracic dorsum with mesoepinotal suture absent or faint .Leptothorax*

Thoracic dorsum with mesoepinotal suture well-marked 14

14. Small ants (length 2-4 mm), scapes not reaching the occipital border; promesonotal suture indistinct or absent; eyes vestigial or small
Stenamma*

Larger ants (length 4-10 mm); scapes usually surpassing the occipital border; thorax usually with distinct promesonotal suture; eyes prominent ....*Aphaenogaster**

Genus *Anergates* Forel

This bizarre parasitic genus contains a single European species (*A. atratulus*), which has been introduced into North America along with its obligate host, *Tetramorium caespitum*. *Anergates* lacks a worker caste, and a mature parasitized colony of *T. caespitum* will contain workers of the latter species, a single reproductive queen of *A. atratulus*, and at appropriate times of year, virgin females and peculiar flightless "pupoidal" males of *A. atratulus*. The species has been collected at scattered localities along the eastern seaboard of the northeastern U.S., from southern New England to Virginia, including Maryland, Delaware, and the District of Columbia. It may yet be found to occur at the SERC site, where *T. caespitum* is locally abundant.

Genus *Smithistruma* Brown

The ants of this genus exhibit perhaps the most specialized morphology of any local Formicidae. *Smithistruma* comprises small (total length less than 3 mm), secretive ants that nest and forage in soil, leaf litter, rotted wood, and similar cryptic microhabitats. The eyes are located subventrally on the subtriangular head, which is typically ornamented with bizarrely specialized hairs. All species whose feeding habits have been studied are predaceous on living springtails (Collembola), which are captured with the aid of an unusual jaw-snapping behavior. Prior to Brown's (1953) revisionary work, these ants were included in the genus *Strumigenys* F. Smith.

Key to the Species of *Smithistruma* Known or Expected in the Chesapeake Bay Region

(Source: Brown 1953)

1. Mandibles very nearly as long as, or longer than, the clypeus, with a toothless diastema equalling or exceeding in length the space occupied by the apical series of teeth ....*pergandei*

   Mandibles considerably shorter than the clypeus; toothless diastema absent or smaller 2

2. Anterior of clypeus forming a blunt raised point that bears a concentrated group of 8-10 long outward-radiating hairs ....*dietrichi**

   Anterior clypeal border rounded; clypeal hairs not concentrated as above, or else with strongly bulbous apices 3

3. Clypeus with a group of 8-10 hairs with strongly bulbous apices radiating from a small anteromedian area; a very long, curved, narrow

erect hair arising on each side near the midlength; surface of clypeus otherwise practically naked ....ornata*

Clypeal pilosity not as above 4

4. Hairs on side of clypeus fine, mostly distinctly J-shaped, curved posterolaterally; mandibles large, diastema very feebly developed, indistinct; clypeus opaque, minutely tuberculate ....ohioensis*

Hairs on sides of clypeus either distinctly apically enlarged or not J-shaped; mandibles smaller with a well-developed diastema 5

5. Clypeus approximately as wide as long and about half as wide as the width across the occipital lobes; mandibles somewhat convex dorsally, diastema very small and indistinct, especially at full closure; preocular laminae straight and distinctly converging anteriorly 6

Clypeus distinctly broader than long and more than half as wide as the width across the occipital lobes, or if width of clypeus is ambiguous, then the mandibles depressed and with a distinct diastema; preocular laminae parallel or very weakly converging, often convex 7

6. Clypeal surface covered densely with short, scale-like appressed hairs; free border with a close fringe of anteriorly directed linear-spatulate hairs ....clypeata

Hairs on clypeal surface not appressed or scale-like; instead, erect or suberect, those projecting from the free border narrow ...pilinasis

7. Most or all of the large hairs on the side of the clypeus curved away from the midline and broadened at their apices ....reflexa

Most or all of the large hairs on the side of the clypeus curved anteriorly or anteromedially (apices broadened or not) 8

8. Pilosity of upper dorsum of head consisting entirely and uniformly of short, curved, spoon-like hairs ....creightoni

Pilosity of upper dorsum of head not uniformly spoon-shaped; at least a few slender erect or suberect hairs on occiput; lateral borders of each occipital lobe often with one or two long, weak outstanding hairs 9

9. Mandibles coarsely and continuously toothed, without a diastema; hairs on sides of anterior clypeal border elongate, narrow, curved semicircularly toward the midline; thorax with four long and conspicuous hairs, one of which occurs at each humeral angle, and one at each side of the thorax where the mesonotal declivity begins ....rostrata*

Mandibles without a distinct toothless diastema; thorax lacking long, conspicuous hairs at the humeral angles 10

10. Clypeal surface with a uniform covering of large, curved spoon-shaped hairs .... abdita

Clypeal surface without hairs in the center, or the hairs in the center much reduced, appressed, and inconspicuous 11

11. Head and mandibles slender; the lateral border of each occipital lobe with a long, fine dorsolaterally curved flagelliform hair) .. pulchella

Head and mandibles more robust; lateral borders of occipital lobes without true flagelliform hairs) .... missouriensis

1. Smithistruma dietrichi (M. R. Smith)

This species has been collected in litter samples from old-field habitats at SERC. The species ranges throughout the southeastern U.S., reaching its northern limit in Maryland.

2. Smithistruma ohioensis (Kennedy and Schramm)

This is by far the most abundant of the four species of Smithistruma known from the SERC site. It has been collected in soil and litter samples from mature and successional forests. Colonies contain 15-50 workers. S. ohioensis is distributed through the southeastern U.S. north to New Jersey.

3. Smithistruma ornata (Mayr)

S. ornata co-occurs with S. ohioensis in leaf litter and soil in mature forest at SERC. The species occurs in the southeastern states as far north as Maryland and Delaware.

4. Smithistruma rostrata (Emery)

This uncommon ant has been collected twice at the SERC site, both times in leaf litter from mature forest. This southeastern species reaches its northern range limit in New Jersey.

Genus Crematogaster Lund

Crematogaster is a large genus of worldwide distribution. Its members are distinguished by possession of a peculiar heart-shaped gaster, and a postpetiole that is joined to the dorsal surface of the abdomen. Many species forage in columns and aggressively defend food sources by smearing intruders with repellent chemicals that are presented on a specialized spatulate sting. Four of the five species of Crematogaster that occur in the Mid-Atlantic region have been collected at the SERC site.

Key to the Species of Crematogaster Known or Expected in the Chesapeake Bay Region

(Source: Buren 1968a)

1. Epinotal spines very short and distinctly incurved; thoracic dorsum smooth to weakly punctate .... ashmeadi

   Without this combination of characters 2

2. Pubescence suberect on at least head and thorax; erect hairs slender and numerous on thorax and gaster 3

   Pubescence appressed on head, thorax, and gaster; erect hairs either rather sparse on thorax and gaster or, if numerous, somewhat bristle-like in appearance 4

3. Pubescence suberect on head and thorax only; thorax smooth or faintly punctate; nests in large variety of semi-arboreal situations in or near swamps, salt marshes, rivers, and streams .... clara*

   Pubescence suberect on gaster and legs as well as on head and thorax; thorax usually with some distinct rugae; often nests in logs and fallen branches in marshy situations .... pilosa*

4. Erect hairs on dorsum of thorax confined to a clump of one to several long, flexuous setae on each shoulder of the pronotum .... cerasi*

   Erect hairs on dorsum bristle-like, numerous, and evenly covering nearly the entire dorsum .... lineolata*

1. Crematogaster cerasi (Fitch)

This species has strong arboreal tendencies, and is fairly common in forest and edge habitats at SERC. It ranges through the northeastern states, and reaches its southern coastal distributional limits in the Chesapeake Bay region. The species extends south into Georgia and Arkansas in the Appalachian and Ozark mountain systems.

2. Crematogaster clara Mayr

This arboreal species is fairly common in woodlands at the SERC site. It ranges through the southeastern U.S. north to New Jersey.

3. Crematogaster lineolata (Say)

This small, black terrestrial species is commonest in brushy old-fields at SERC, but occurs also in dry, open woods. The range encompasses most of the eastern deciduous forest region, from northern New England and southern Ontario south to the Gulf states.

4. Crematogaster pilosa Emery

While this secretive species has rarely been observed actively foraging aboveground at the SERC site, it is fairly common in the litter zone within deciduous forest. The range of C. pilosa includes the Middle Atlantic region between Georgia and New Jersey.

Genus Solenopsis Westwood

Solenopsis is a very large, cosmopolitan genus whose members, although structurally similar, exhibit a remarkable range in body size, behavior, and habitat associations. At one extreme are the tiny (2-3 mm total length) highly convergent members of the subgenus Diplorhoptrum, various species of which are arboreal, terrestrial, or subterranean. Members of the subgenus Solenopsis, on the other hand, are considerably larger (major workers are 4-8 mm total length), aggressive, terrestrial species that tend to be associated with deserts, grasslands, and other fairly open habitats. One non-native species of this subgenus, the notorious Red imported fire ant (S. invicta), has gradually expanded its range to include most low-lying areas of the southeastern U.S. as far north as North Carolina. While S. invicta may yet appear in the Chesapeake Bay region, only members of the subgenus Diplorhoptrum are presently known from the area. Associated females are most helpful for identification of Diplorhoptrum workers.

Key to the Species of Solenopsis Known or Expected in the Chesapeake Bay Region

(Source: Creighton 1950)

1. Female with very large eyes which cover more than half the sides of the head ....carolinensis

   Female with smaller eyes that do not cover half the sides of the head 2

2. Funicular joints 3, 4, and 5 of the worker notably broader than long; color pale yellow, the gastric segments slightly infuscated; the gaster of the female pink orange in life ....texana

   Funicular joints, 3, 4, and 5 only slightly broader than long, gaster clear golden yellow or darker; female gaster not as above ....molesta*

1. Solenopsis molesta (Say)

At the SERC site this tiny (ca. 2 mm total length) pale-colored species is commonest in old-fields and other open habitats, but occurs occasionally in forested areas. S. molesta is largely subterranean, but surface mobilizations of workers are sometimes observed at night. Oily, proteinaceous foods are strongly preferred over carbohydrates. The species ranges throughout eastern North America from the Gulf states to southern Canada and northern New England, and occurs in the Pacific and Rocky Mountain areas.

Genus *Trachymyrmex* Forel

Most species in this New World genus occur in Latin America and the Caribbean region. A few species range into the southwestern U.S., and one (*T. septentrionalis*) is widely distributed through the eastern states between Texas and New York. The species is evidently scarce on the western shore of Chesapeake Bay (it does not occur at the SERC site), but occurs in loose sandy soils along the Atlantic coast between Long Island and Florida. *T. septentrionalis* utilizes a mixture of caterpillar dung, oak catkins, and other vegetable material as a substrate for cultivating subterranean fungus, the major source of food for this and other members of the myrmicine tribe Attini (Weber 1972).

Genus *Harpagoxenus* Forel

The three species that comprise this Holarctic genus obligatorily enslave species of the related genus *Leptothorax*. Colonies of *Leptothorax* are raided by small parties of *Harpagoxenus* workers, which capture *Leptothorax* larvae and pupae to be reared as slaves. One of the two North American species of *Harpagoxenus* occurs in the Middle Atlantic region.

1. *Harpagoxenus americanus* (Emery)

This small, rather non-descript, dark brown species has been collected several times at the SERC site, where it enslaves the pale-yellow *Leptothorax curvispinosus*. Elsewhere, *H. americanus* is known to enslave *L. longispinosus*, a black species that also occurs at SERC. Colonies of *H. americanus* typically contain less than a dozen *H. americanus* reproductives and workers, together with up to 25 or so *Leptothorax* workers. Most colonies have been found in arboreal twigs within forested areas, but they also occur in superficial litter. The species ranges from central New England and southern Ontario south to North Carolina and west to Illinois and Missouri.

Genus *Leptothorax* Mayr

Leptothorax is a cosmopolitan genus made up of small, generally timid ants, that often place their modest colonies within hollow twigs, fallen nuts, and other preformed cavities. Four of the five species in the Middle Atlantic region belong to the subgenus *Myrafant*, and possess 11 antennal segments; the exceptional species (*L. pergandei*) has a 12 segmented antenna, and belongs to the subgenus *Dichothorax*. All five species have been collected at the SERC site.

Key to the Species of *Leptothorax* Known or Expected in the Chesapeake Bay Region

(Source: Creighton 1950)

1. Antenna 12-jointed; color piceous brown ....*pergandei**

   Antenna 11-jointed; color yellow, brown, or black 2

2. Epinotal spines longer than 1/2 the distance that separates their bases; color yellow or brown 3

Epinotal spines short and dentiform, their length less than 1/2 the distance that separates their bases; color brown ....schaumi*

3. Dorsal surface of the head in large part strongly shining; longitudinal rugae, if present, sparse and feeble, the inter-rugal sculpture consisting of small widely scattered punctures; color black longispinosus*

Dorsal surface of head feebly shining or completely opaque, the sculpture variable but never of a character to give the surface a smooth and strongly shining appearance; color yellow 4

4. Epinotal spines very long, recurved, and set close together at the base; postpetiole, seen from above, very little broader than long; color pale yellow; color yellow ....curvispinosus*

Epinotal spines shorter, well-separated at the base; postpetiole, seen from above, notably broader than long; color orange-yellow ..ambiguus*

Note: This key does not include L. minutissimus, a species known only from the type series of females collected in the District of Columbia.)

1. Leptothorax (Myrafant) ambiguus Emery

This is the common Leptothorax of old-fields and other open habitats at SERC. L. ambiguus superificially resembles L. curvispinosus, a forest-dwelling species, but is more terrestrial than the latter. The range of L. ambiguus extends from Quebec and Ontario south to Virginia and west to Iowa, Nebraska, and the Dakotas.

2. Leptothorax (Myrafant) curvispinosus Mayr

L. curvispinosus is virtually ubiquitous in forested habitats at SERC and elsewhere in eastern North America. The yellow workers forage slowly over leaf surfaces and on the ground. Colonies are located within dead twigs of standing trees, in fallen twigs and nuts, and in superficial litter. Although L. curvispinosus occasionally coexists with L. ambiguus in brushy old-fields, the two species are largely segregated by habitat, with L. ambiguus occupying more open situations. L. curvispinosus ranges through most of the eastern North America from southern Canada to the Gulf states.

3. Leptothorax (Myrafant) longispinosus Roger

The shining black integument of this ant distinguishes it from all other local species except the smaller Monomorium minimum. L. longispinosus co-occurs with L. curvispinosus in forested areas at SERC, but is markedly less abundant and more terrestrial than the latter species. The

ranges of the two species are similar, but _L_. _longispinosus_ does not occur as far south at the Gulf region.

4. _Leptothorax_ _(Myrafant)_ _schaumi_ Roger

This species has been collected only once at SERC. Coloration is highly variable, and workers from a single colony may range from yellow to dark brown. The range extends from New England to Georgia.

5. _Leptothorax_ _(Dichothorax)_ _pergandei_ Emery

The sole SERC record for this rather nondescript brown _Lepthorax_ is a single worker collected in a forested area. The species ranges through the southeastern U.S., from the Gulf of Mexico to New Jersey.

Genus _Myrmica_ Latrielle

Myrmica is a Holarctic genus, with numerous representatives in North America, northern Europe, and northern Asia. In eastern North America, _Myrmica_ ranges from Labrador to Tennessee and North Carolina, but southern occurrences are mainly at high elevations. The taxonomy of _Myrmica_ is notoriously difficult, and the genus is currently under revision. The two species that have been taken at SERC are easily distinguished morphologically, as well as by habitat association.

Key to the Species of _Myrmica_ Known or Expected in the Chesapeake Bay Region

(Source: Creighton 1950)

1. Antennal scape gradually and evenly bent at the base, the upper surface never forming a right angle at the bend; the lamina, if present, forming a low and inconspicuous ridge at the side of the bend and never prolonged onto the upper surface of the scape 2

   Antennal scape sharply bent at the base, the upper surface forming a right angle; lamina always present and of varying shapes, but never absent from the upper surface of the scape 3

2. Epinotal spines about one and one-half times as long as the distance that separates their bases and slightly deflected downward; color piceous brown; length 4.0 - 4.7 mm (antennal scape of the male as long as the following 6 segments taken together) ....*punctiventris**

   Epinotal spines only slightly longer than the distance that separates their bases and not deflected downward; color brownish yellow; length 3.5 - 4.0 mm (antennal scape of the male as long as the following 2 segments taken together) ...._pinetorum_

3. Ventral surface of the postpetiole seen in profile flat or nearly so and not forming a projection in front; antennal scape of the male as

long or longer than the following 4 segments taken together and straight at the base ....americana*

Ventral surface of the postpetiole seen in profile convex or forming a prominent anterior projection that thrusts forward under the anterior peduncle; antennal scape of the male bent at the base or, if straight, distinctly shorter than the above 4

4. Lamina of the antennal scape small and diagonally transverse on the upper surface of the scape but continued as a prominent transparent flange along the inner surface of that part of the scape that lies below the bend; antennal scape of the male straight at the base and only as long as the following 3 segments taken together ......emeryana

Lamina small and transverse, but forming an angular tooth-like projection on the inner side of the bend; no prominent median flange as above; antennal scape of male bent at the base and at least as long as the following 5 segments taken together ....lobicornis

1. Myrmica americana Weber

This species is a common inhabitant of old-fields and other exposed habitats at SERC. It is unusually tolerant of low temperatures and is active even on cold nights. The distribution extends from New England and southern Quebec south to Tennessee and North Carolina, and west to the Rocky Mountain region.

2. Myrmica punctiventris Roger

In forested areas, M. punctiventris replaces M. americana as the common local Myrmica species. Both species are terrestrial, slow-moving, and relatively timid. M. punctiventris favors humid, mature forest. The species ranges from southern New England south to Georgia, and west to the Plains states.

Genus Myrmecina Curtis

One of the two subgenera of Myrmecina ranges through southwest Asia, Oceania, and northern Australia; the other has a holarctic distribution. Only a single widespread species of the latter group occurs in North America. It is one of the common woodland ants at the SERC site.

1. Myrmecina americana Emery

This fairly small, dark brown species is common in moist forest, but its cryptic habits make it difficult to observe. Colonies are small (generally less than 100 workers) and are located in the soil. The workers feign death when disturbed. M. americana occurs in three disjunct geographic regions: eastern North America from northern New England and Quebec to Tennessee, and west to Missouri and Nebraska; the Rocky Mountains; and the Pacific coastal region.

Genus *Tetramorium* Mayr

This Old World genus is represented in the New World by a number of "tramp" species that have been introduced inadvertently through human commerce. Most of the introduced forms occur in tropical or subtropical areas, but a single species ranges through temperate North America.

1. *Tetramorium caespitum* (Linné)

This aggressive dark-brown species is native to Europe, but is now established throughout the eastern half of the U.S., as well as in the Pacific states. The species forms large colonies that may contain several reproductively active females. Heavily disturbed situations (e.g., roadsides, lawns, pastures, agricultural fields) are favored by *T. caespitum* at SERC.

Genus *Monomorium* Mayr

Most members of this cosmopolitan genus occur in the Old World, but a few species are native to North America. One of these (*M. minimum*) is among the commonest ants in North America. *Monomorium* are slender, minute ants that nest either directly in the ground or in hollow twigs, fallen nuts, and other preformed cavities. One species, *M. pergandei*, is a workerless parasite on *M. minimum*. *M. pergandei*, which is known only from the type series collected in Washington, D.C., was formerly placed in the monotypic genus *Epoecus*, but following Ettershank (1966) and Brown (1973) I have included it within *Monomorium*.

Key to the Species of *Monomorium* Known or Expected in the Chesapeake Bay Region

(Source: Creighton 1950)

1. Workers absent; males and females very similar in form ......*pergandei*

   Workers present; males and females strongly dimorphic 2

2. Node of petiole, in profile, somewhat higher than its base is long, with the anterior peduncle about as long as the base of the node; mesopleurae and base of the epinotum rugose or delicately striate *viridum*

   Node of the petiole, in profile, approximately as high as it is long with the anterior peduncle notably shorter than the base of the node; mesopleurae and the base of the epinotum for the most part smooth and shining ....*minimum**

1. *Monomorium minimum* (Buckley)

This minute (3 mm), shining black ant is extremely abundant in open fields at the SERC site, and also occurs in forest clearings. The species usually nests directly in the soil, but workers forage both terrestrially

and above the ground in trees, shrubs, and herbaceous vegetation. Workers form dense mobilizations at concentrated food sources. The species occurs through eastern North America from northern New England south to the Gulf region, and southwestward to Arizona and the Pacific coast.

Genus *Pheidole* Westwood

Most of the several hundred species in this cosmopolitan genus occur in tropical and subtropical areas, and temperate zone species tend to be associated with relatively dry, exposed habitats (Brown 1973). The most conspicuous characteristic of *Pheidole* is the presence of a strongly dimorphic worker caste in almost all species. Minor workers posses a relatively generalized myrmicine morphology, but major workers ("soldiers") exhibit greatly enlarged head and jaws. All five of the *Pheidole* species that occur in the Chesapeake Bay region have been collected at the SERC site, where they are associated with pastures, old-fields, and other open habitats. Both major and minor workers are needed for identification of some *Pheidole* to species.

Key to the Species of *Pheidole* Known or Expected in the Chesapeake Bay Region

(Source: Creighton 1950, Gregg 1958)

1. The tops of the occipital lobes of the major worker and usually their front faces as well, covered with sculpture ....*pilifera**

   The tops of the occipital lobes of the major worker and usually their front faces as well, free from sculpture 2

2. Entire thorax of minor worker covered with granulose sculpture and completely opaque; postpetiole of minor, seen from above, spherical *davisi**

   At least a part of the promesonotum shining in the minor worker, or, if the entire thorax is opaque, the promesonotum is longitudinally striate and not densely granulose; postpetiole of minor worker, seen from above, not spherical 3

3. Epinotum of the major worker angular at the junction of the basal and declivous faces, but the angles not produced into distinct teeth or spines (length of major 3.5-4.0 mm) ....*morrisi**

   Epinotum of major worker armed with distinct teeth or spines 4

4. Mesonotum of the major worker depressed below the adjacent portion of the pronotum, so that in profile it forms a distinct step or angular projection between the pronotum and the epinotum (length of major 3.4-3.8 mm) ....*dentata**

   Mesonotum of the major worker not depressed below the adjacent portion of the pronotum, in profile the two forming an evenly curved outline

which descends to the mesoepinotal suture (length of major 2.6-3.0 mm) bicarinata*

1. Pheidole bicarinata Mayr

This tiny yellow species is the commonest member of the genus at the SERC site, where it occurs mainly in abandoned fields. The species occurs from New York south to Florida, and west to the Dakotas, with isolated populations in the Rocky Mountains and California.

2. Pheidole davisi Wheeler

This small, dark brown ant is fairly common in old-field habitats at SERC. It ranges south from New Jersey to the highlands of northern Alabama and Georgia.

3. Pheidole dentata Mayr

This and P. morrisi are the largest of the five local Pheidole species. The honey-yellow workers of P. dentata forage terrestrially in dry, exposed habitats at SERC, although the species occurs in open woodlands further south. This southeastern species reaches its northern distributional limit in the Chesapeake Bay region.

4. Pheidole morrisi Forel

The absence of epinotal spines and the dark-brown body color distinguish this species from the otherwise similar P. dentata. At SERC, P. morrisi has been taken only in old-fields. The species occurs throughout the southeastern U.S. north to New York.

5. Pheidole pilifera (Roger)

This small, dark species is apparently rare at the SERC site. The few collections all have been made in highly disturbed situations (e.g., lawns, roadsides). The several subspecies of P. pilifera occur from southern New England to Florida, and west to California. Iowa and Nebraska, with isolated occurrences in the Dakotas, the Rocky Mountain region, and in coastal California.

Genus Stenamma Westwood

This holarctic genus is represented by four species in the Middle Atlantic region; all occur at the SERC site. The ants of this genus are small to medium-sized, terrestrial, and timid. Their colonies typically number fewer than 100 workers. Food habits have been little-studied, but Stenamma presumably preys mainly on scavenged insects.

Key to the Species of Stenamma Known or Expected in the Chesapeake Bay Region

(Source: Smith 1957)

1. Larger species (length 2.8-4.0 mm); eye usually with 5-12 ommatidia in its greatest diameter ....brevicorne*

   Smaller species (length 2.3-3.5 mm); eye with 3-6 ommatidia in its greatest diameter 2

2. Thorax either shining on the promesonotum, or the general surface of the thorax not dulled throughout the numerous, dense and distinct punctures 3

   Thorax subopaque, the sculpturing highly variable but always of such a nature that the punctures are dense enough to dull the general surface regardless of their position or abundance ....schmitti*

3. Small species (2.3-2.7 mm in length); thoracic sculpture weak; postpetiole seldom noticeably smooth and shining; ommatidia of eye unusually coarse; petiolar node in profile subangular or angular) ...impar*

   Larger species (2.7-3.5 mm in length); thoracic sculpturing highly variable but seldom weak, the promesonotum usually distinctly shining; postpetiole usually smooth and rather strongly shining ....diecki*

1. Stenamma brevicorne (Mayr)

The sole SERC record for this large-eyed species is a worker from a litter sample collected in a brushy old-field. The species ranges through the northeast from the Maritime Provinces, southern Quebec, and Ontario, south to Virginia, and west to Minnesota and Nebraska.

2. Stenamma diecki Emery

This medium-sized species is common in the litter and soil horizons within forested habitats at SERC, where it co-occurs with S. impar. The species occurs across much of temperate North America below the latitude of northern New England and southern Quebec in the east, and southern British Columbia in the west. The southern limit of the range is North Carolina in the east, and northern Mexico in the west.

3. Stenamma impar Forel

S. impar is by far the commonest member of the genus at the SERC site. Its small colonies are numerous in the soil and litter zones within forested areas. The species occurs through most of northeastern North America from the latitude of southern New England south to North Carolina, and west to the Dakotas.

4. Stenamma schmitti Wheeler

The two SERC records for this species stem from workers collected in leaf litter within a tract of mature forest. The range is similar to that of S. impar.

Genus Aphaenogaster Mayr

Six species belonging to this virtually cosmopolitan genus occur in the Middle Atlantic region; five of these have been collected at the SERC site. The sixth species (A. mariae) is known from scattered localities between the latitudes of New York and Florida, and eventually may be discovered locally. All Aphaenogaster that occur in the local area are moderately large ants with a body color that ranges from brown-black to orange-brown. Most species are associated with wooded situations, but A. treatae is characteristic of old-fields and other open habitats. Some species are important agents of seed dispersal for woodland herbs. All of the local species share the habit of covering concentrations of liquid food with bits of debris, which are later carried back to the nest after soaking up substantial amounts of the food (Fellers and Fellers 1976).

Key to Species of Aphaenogaster Known or Expected in Chesapeake Bay Region

(Source: Creighton 1950)

1. Antennal scape with a conspicuous lobe which extends rearward along the basal fourth or fifth of the scape ....treatae*

   Antennal scape without a basal lobe, or if small lobe is present, it projects forward and does not involve the basal fifth of the scape ..2

2. Basal quarter of the first gastric segment with delicate striae which spread fan-like from the attachment of the postpetiole ....mariae

   Gaster without basal striae 3

3. Outer face of the frontal lobe bearing a flange which projects rearward in the form of a tooth ....lamellidens*

   Outer face of the frontal lobe without a toothed flange 4

4. Postpetiole broader than long and suboval in shape; epinotal spines longer than the basal face of the epinotum ....tennesseensis*

   Postpetiole as long as broad, or longer than broad; globular or like a truncated cone in shape; epinotal spines, shorter than the basal face of the epinotum 5

5. Anterior edge of the mesonotum rising abruptly above the adjacent portion of the pronotum, the transverse welt thus formed distinctly concave in the middle; epinotal spines at least as long as the declivious face of the epinotum and strongly directed upwards .....fulva*

Mesonotum not abruptly elevated above the pronotum or, if it is higher, the anterior edge not forming a transverse welt; epinotal spines shorter than the declivous face of the epinotum and directed backward rudis*

1. Aphaenogaster fulva Roger

This is one of the two commonest members of the genus in wooded areas at SERC. Colonies are generally located within fallen logs or rotted stumps, and workers forage on the forest floor. A. fulva differs from A. rudis, the other common forest Aphaenogaster, in having black-infused antennae and legs. A. fulva ranges through most of the eastern deciduous forest region of North America from northern New England to Florida.

2. Aphaenogaster lamellidens Mayr

Like A. fulva, this species possesses darkened appendages, but the ground color of A. lamellidens is noticeably lighter (orange rather than brown-black), and the workers are larger than those of A. fulva. At the SERC site A. lamellidens prefers somewhat open wooded sites, where it places its colonies under stones or inside dead tree trunks. The species ranges from New York to Florida, west to Illinois, Missouri, and Texas.

3. Aphaenogaster rudis (Emery)

A. rudis is perhaps the commonest surface-foraging ant species in forested areas of Eastern North America, including the SERC site where its foraging ecology has been studied (Lynch et al. 1980; Lynch 1981). Colonies are of moderate size (200 - 300 workers), and are typically placed in the soil, with or without a cover object. Workers forage mostly for scavenged animal material, but plant material (mushrooms, seeds, fruits) are also taken. Ants classified as A. rudis range through eastern North America from the Maritime Provinces to the Gulf region, but the discovery of chromosomally distinct cryptic species within A. "rudis" (Crozier 1977) has complicated the taxonomic picture.

4. Aphaenogaster tennesseensis (Mayr)

This striking orange-colored species is the most arboreal of the Aphaenogaster that occur at the SERC site. Nests are usually located within standing dead trees that retain a sheath of loose bark, but stumps are occasionally utilized as nest sites. Workers forage both arboreally and terrestrially, and commonly form large mobilizations at concentrated food sources. A. tennesseensis is thought to be an obligate temporary social parasite on A. rudis or A. fulva (Creighton 1950). The queen of A. tennesseensis is unusually small and possesses a shiny integument that is free of pilosity. These morphological features are thought to be related to her invasion of alien Aphaenogaster colonies during the nest-founding stage. This species occurs from New England and southern Ontario south to the Gulf region and west to the plains states.

5. Aphaenogaster treatae Forel

This large, long-legged species is associated with old-fields and other open habitats that support a rich cover of herbaceous and shrubby vegetation. It ranges from Ontario to Florida, and westward to Texas, and Oklahoma.

Subfamily DOLICHODERINAE

Although the Dolichoderinae have a cosmopolitan distribution, the center of diversity for this subfamily is in the southern hemisphere (Brown 1973). Only four dolichoderine genera range through the Chesapeake Bay area, and three of these occur at the SERC site. The fourth genus (Conomyrma) is a basically southern group whose distribution in the Middle Atlantic region is restricted to exposed sandy soils along the Atlantic coast.

Key to the Genera of the Subfamily Dolichoderinae Known or Expected in the Chesapeake Bay Region

(Source: Creighton 1950)

1. Declivous face of the epinotum very strongly concave; integument stiff and brittle; epinotum and often much of the remainder of the thorax heavily sculptured ....Dolichoderus*

   Declivious face of the epinotum straight or nearly so; integument thin and flexible; sculpture everywhere fine or absent 2

2. The epinotum with a prominent, sharp, tooth-like protuberance projecting vertically at the junction of the basal and declivous faces; third segment of the maxillary palp very long, as long or longer than the three succeeding segments taken together ....Conomyrma

   The junction between the basal and declivous faces of the epinotum unarmed, rounded or angular; third segment of the maxillary palp not unusually long and notably shorter than the three succeeding segments taken together 3

3. Scale of the petiole vestigial ....Tapinoma*

   Scale of the petiole long enough for the tip to project beyond the overhanging anterior face of the gaster ....Iridomyrmex*

Genus Dolichoderus Lund

All North American representatives of this cosmopolitan genus are members of the subgenus Hypoclinea, which is accorded full generic rank by some authors. Four species occur in the mid-Atlantic states, but two of these (D. mariae and D. taschenbergi) nest mainly in loose sandy soils, and

are not found at the SERC site. All four eastern Dolichoderus are associated with fairly exposed habitats, ranging from marsh edges to old-fields and open woodlands.

Key to the Species of Dolichoderus Known or Expected in the Chesapeake Bay Region

(Source: Creighton 1950)

1. Cephalic foveolae coarse, deep and very close-set so that the surface between them forms a reticulo-rugose pattern; the antennal scapes with numerous short, erect hairs on their anterior surfaces .....plagiatus*

   Cephalic foveolae shallow, often replaced on the front and vertex by small punctures; the foveolae well separated with the surface between them delicately shagreened and never forming a reticulo-rugose pattern; antennal scapes usually without erect hairs, rarely one or two present 2

2. Epinotum, seen from above, subquadrate, very slightly or not at all longer than broad; color uniform brownish black or piceous taschenbergi

   Epinotum, seen from above, very distinctly longer than broad; alitrunk lighter than the gaster, often bicolored 3

3. Dorsum of the epinotum and mesonotum with coarse, deep, close-set foveolae forming a reticulo-rugose pattern; mesopleuron very smooth and shining ....pustulatus*

   Dorsum of the epinotum and mesonotum granulose or densely shagreened, foveolae, if present, shallow and obscure; mesopleuron in large part or entirely shagreened, subopaque, or dull ....mariae

1. Dolichoderus plagiatus (Mayr)

This species has been taken occasionally in young successional woods at the SERC site. The species ranges through eastern North America from the maritime provinces southward to the highlands of Georgia and Tennessee, and west to the great plains.

2. Dolichoderus pustulatus Mayr

This species occurs in old-fields, marsh edges, and other open habitats at SERC. Nests are common inside dead stems of the tall marsh grass Spartina cynosuroides. The species occurs from the Maritime Provinces and southern Ontario south to the Gulf region, and west to Illinois, Oklahoma, and Texas.

Genus Iridomyrmex Mayr

Brown (1973) has argued that the North American species assigned to this predominantly Old World genus should be reassigned to the related genus Forelius, but no formal taxonomic revision has so far been undertaken. Iridomyrmex (sensu lato) are active, aggressive ants that occur mainly in tropical and subtropical areas. One native species is widely distributed in temperate North America. An introduced South American form (I. humilis) has become established outdoors in some sections of California and the Gulf States, and has been reported occasionally from greenhouses and similar protected sites in the mid-Atlantic region.

Key to the Species of Iridomyrmex Known or Expected in the Chesapeake Bay Region

(Source: Creighton 1950)

1. The antennal scape in repose surpassing the occipital margin by an amount equal to or somewhat greater than the length of the first funicular joint; the middle of the occipital margin flat or somewhat convex; alitrunk usually without erect hairs ....humilis

   The antennal scape in repose surpassing the occipital margin by an amount approximately equal to one-half the length of the first funicular joint; the middle of the occipital margin broadly but feebly impressed; usually a few erect hairs on the promesonotum .....pruinosus*

1. Iridomyrmex pruinosus (Roger)

This small pale brown species occurs in highly disturbed, exposed situations at the SERC site. Most local occurrences are in areas where bare soil is visible, and daytime substrate temperatures reach high levels during summer. Workers are rapid and erratic in their movements, particularly at high temperatures. The range of I. pruinosus encompasses low lying terrain across most of North America south of latitude 42° N.

Genus Tapinoma Forester

Only a single species of this cosmopolitan genus occurs in the mid-Atlantic region.

1. Tapinoma sessile (Say)

This small brown-black species is by far the most abundant and widely distributed dolichoderine in the Chesapeake Bay region, including the SERC area. It forms large colonies (2,000-5,000 workers) that may contain as many as 200 reproductively active females (Smith 1928). The species frequently shifts its nest site, and appears to be well adapted for exploitation of disturbed habitats (e.g., floodplains, successional fields, human habitations). T. sessile is scarce in relatively undisturbed woodlands at the SERC site. The species occurs from coast to coast, except for desert regions, between the latitudes of southern Canada and southern Mexico.

Subfamily FORMICINAE

Most species in the 12 North American genera in this family are members of Formica or Camponotus. Ants of these two genera are large, active, species with variable ecological requirements and diverse habits. Formicines run the gamut from arboreal through terrestrial to fully fossorial, and are found in habitats that range from open crop-lands and old-fields to dense forest. Eight genera occur in the Chesapeake Bay region.

Key to the Genera of Formicinae Known or Expected in the Chesapeake Bay Region

(Source: Creighton 1950)

1. Antennae with 9 segments (size less than 3 mm) .... Brachymyrmex*

   Antennae with 12 segments (size greater than 3 mm) 2

2. In profile, thoracic dorsum evenly convex, the epinotum not depressed below the level of the promesonotum, the mesoepinotal suture unimpressed or very slightly impressed; mesothoracic spiracles borne on the sides of the thorax at a level well below the basal face of the epinotum; the antennal scapes usually inserted well behind the posterior edge of the clypeus .... Camponotus*

   In profile, thoracic dorsum with the epinotum distinctly depressed below the level of the promesonotum; the impression at the mesoepinotal suture always distinct and often profound; mesonotal spiracles usually occurring in this impression on or close to the dorsal surface of the thorax; antennal scapes inserted at or near the posterior border of the clypeus 3

3. Mandibles sickle-shaped, their inner border microscopically serrate; maxillary palps with 4 segments; labial palps with 2 segments; color red .... Polyergus*

   Mandibles triangulate with a distinctly dentate masticatory margin; number of maxillary and labial palps different from the above; color variable 4

4. Maxillary palps very short and consisting of 3 segments; color pale yellow, eyes very small .... Acanthomyops*

   Maxillary palps longer, consisting of 6 segments; color usually red, brown, or black; eyes usually larger 5

5. Frontal carinae prominant, their lateral margins slightly reflected upward; ocelli very distinct .... Formica*

   Frontal carinae poorly marked, their lateral margins flat; ocelli indistinct or absent 6

6. Antennal scapes surpassing the occipital margin by at least one-third their length, usually much longer; erect body hairs, when present, long, coarse and brown or black in color 7

Antennal scapes never surpassing the occipital margin by an amount greater than the length of the first funicular joint, often much shorter; erect body hairs short, fine, and golden in color ....Lasius*

7. Alitrunk seen from above with the mesonotum very strongly compressed; coarse, erect dark hairs absent ....Prenolepis*

Alitrunk seen from above with the mesonotum slightly compressed; abundant coarse, dark, erect hairs present on head and body Paratrechina*

Genus Brachymyrmex Mayr

This is a New World genus with two or three North American representatives. Brachymyrmex are tiny, fragile ants with subterranean habits.

1. Brachymyrmex depilis Emery

Although this tiny, pale yellow species is almost never seen at the surface, it is the most abundant ant in the soil zone at SERC (Lynch et al. 1988). Little is known of its feeding habits. The species occurs from Nova Scotia to Florida, and westward to British Columbia and California.

Genus Camponotus Mayr

This cosmopolitan group is perhaps the most species-rich of all ant genera (Brown 1973). Four of the numerous proposed subgenera occur in the study area. Members of the subgenera Camponotus and Tanaemyrmex are the largest local ants, and mainly forage terrestrially. The subgenus Colobopsis contains much smaller arboreal species that are highly modified for nesting inside hollow twigs. The subgenus Myrmentoma contains mainly arboreal species that are intermediate in their size and degree of morphological specialization. The key requires major workers.

Key to the Subgenera of Camponotus Known or Expected in the Chesapeake Bay Region

(Source: Creighton 1950)

1. Head of the major worker circular in cross section and abruptly truncated in front, the truncated portion consisting of the clypeus and adjacent parts of the cheeks; media workers absent; length of major workers at most 6 mm ....Subgenus Colobopsis*

Head of the major worker not as above; if truncated the slant is oblique and involves the frontal lobes as well as the clypeus; media workers present; length of major workers greater than 6 mm 2

2. Anterior border of the clypeus feebly projecting, depressed in the middle and with a narrow, medial notch, behind which is a short, triangular impression; length of the major worker at most 8 mm Subgenus Myrmentoma*

Anterior border of the clypeus not as above, usually without a medial notch, but when one is present there is no impression behind it; length of major worker rarely less than 8mm and usually much more ...3

3. Clypeus ecarinate or scarcely carinate; antennal scapes never flattened at the base; clypeal fossae well-marked; head of the major worker (mandibles excluded) at least a little broader than long Subgenus Camponotus*

Clypeus distinctly carinate or, if feebly carinate, the antennal scape flattened at the base; antennal fossae shallow over most of their length; head of the major worker (mandibles excluded) as long or distinctly longer than broad ....Subgenus Tanaemyrmex*

Key to the Species of Camponotus Known or Expected in the Chesapeake Bay Region

(Source: Creighton 1950)

A. Subgenus Camponotus

1. Pubescence on the gaster absent or very fine and sparse, the entire surface of the gaster distinctly shining 2

   Pubescence on the gaster coarse and dense, the surface of the gaster dull except for a narrow band at the posterior edge of each segment 3

2. Punctures on the head coarse and conspicuous; head and gaster brownish black, alitrunk red ....novaeboracensis

   Punctures on the head fine and inconspicuous; color very variable but the alitrunk never red ....americanus*

3. Entire head, alitrunk, petiole and gaster dull black; pubescence of gaster pale yellow or white ....pennsylvanicus*

   Posterior portion of the alitrunk, petiole and base of the first gastric segment bright, ferrugineous red; pubescence of gaster golden yellow ....ferrugineus*

B. Subgenus Tanaemyrmex

1. Color uniform castaneous brown ....castaneus*

C. Subgenus Myrmentoma

1. The major workers and larger media workers with numerous short, erect hairs arising from coarse, oval foveolae on the cheeks ...2

The foveolae on the cheeks of the major workers and larger workers small and hairless (color usually black) .....<u>nearcticus</u>*

2. Erect hairs on the cheeks and clypeus all of approximately the same length and of equal abundance (color uniform piceous black) <u>caryae</u>

Erect hairs on the clypeus notably longer and a little less abundant than those on the cheeks (color mottled brown) <u>subbarbatus</u>*

D. Subgenus <u>Colobopsis</u>

1. Head and thorax brown, gaster brown-black ....<u>impressus</u>*

1. <u>Camponotus</u> (<u>Camponotus</u>) <u>americanus</u> Mayr

This large dirty-yellow species is mainly nocturnal. It occurs sporadically in wooded and brushy habitats at SERC. The species ranges from New England and southern Ontario south to the Gulf region and west to the Great Plains.

2. <u>Camponotus</u> (<u>Camponotus</u>) <u>ferrugineus</u> (Fabricius)

Long considered a color form of the all-black <u>C. pennsylvanicus</u>, this striking red-and-brown species is now accorded full species status. It is the most abundant large <u>Camponotus</u> at the SERC site, where it is confined to wooded areas. Its activity shows a strong nocturnal mode (Lynch et al. 1980). The nest is generally located inside a stump or fallen log. The range of <u>C. ferrugineus</u> extends from New England and New York south to Georgia, and west to the Plains states.

3. <u>Camponotus</u> (<u>Camponotus</u>) <u>pennsylvanicus</u> (De Geer)

This large, uniform black species co-occurs with <u>C. ferrugineus</u> in forested areas, but is distinctly less common than the latter species at SERC. The two species are similar in their foraging habits, but <u>C. pennsylvanicus</u> tends to nest in standing trees rather than downed logs. The range of <u>C. pennsylvanicus</u> completely encompasses that of <u>C. ferrugineus</u>, extending south to the Gulf region and west to the 100th meridian.

4. <u>Camponotus</u> (<u>Colobopsis</u>) <u>impressus</u> (Roger)

The plug-shaped head of the dark brown major workers is used to block the nest entrance within hollow twigs. This species is common in the southeastern U.S., but rare at the SERC site, which is near the northern limit of the range. In the study area <u>C. impressus</u> generally nests inside dead grass stems, or in twigs on living trees or shrubs, generally at the margins of fields or marshes. The tall marsh grass <u>Spartina cynosuroides</u> is a favored nest plant. The species ranges through the southeastern U.S. from central Texas and the Gulf region to the Chesapeake Bay region.

5. Camponotus (Myrmentoma) subbarbatus Emery

Workers of this small, mottled-brown species are commonly encountered in low arboreal situations in second-growth woods and forest edge habitat. The species ranges throughout the northeastern U.S. south about to the latitude of Virginia.

6. Camponotus (Myrmentoma) nearcticus Emery

This small usually all-black species is common in humid, forested habitats in both eastern and western North America, from the latitude of northern New England and British Columbia southward to the Gulf states and California. The nest is generally located off the ground in a standing dead tree trunk or limb.

7. Camponotus (Tanaemyrmex) castaneus (Latreille)

The range of this large, brown or yellow-brown species encompasses most of the eastern deciduous forest region. The species coexists with C. ferrugineus and C. pennsylvanicus in forested areas, but appears to be much less common, at least at the SERC site.

Genus Paratrechina Motschulsky

The North American representatives of this cosmopolitan genus are small, fast-moving ants with a preference for carbohydrate-rich foods. The taxonomy of the group, which was characterized by Creighton (1950) as "most depressing" has been clarified by the recent revision of Trager (1984). Reliable identification of specimens in the field may be impossible where more than one species co-occur, but so far only a single species (P. faisonensis) has been found at the SERC site. At least one other native form (P. parvula) ranges through the Middle Atlantic coastal plain region. In addition, P. pubens and P. vividula have been found sporadically in greenhouses throughout the eastern U.S. as far north as New Jersey.

Key to Workers of the Species of Paratrechina Known or Expected in the Chesapeake Bay Region

(Source: Trager 1984)

1. Antennal scapes with no more than 4 standing erect hairs ......parvula

   Antennal scapes with at least 4 (usually 7 or more) erect hairs 2

2. Thorax and gaster mostly covered with pubescence; dull ....pubens

   Thorax and gaster with greatly reduced pubescence; shining 3

3. Cephalic pubescence sparse; spaces between most erect hairs in pre-occipital area at least as wide as the length of the hairs; anterior half of head with little or no pubescence ....vividula

Cephalic pubescence dense; spaces between erect hairs in preoccipital region mostly narrower than length of hairs; anterior portion of head pubescent ....faisonensis*

1. Paratrechina faisonensis (Forel)

This small black species is one of the commonest ants in woodlands at the SERC site. Its ecology has been described (under the name P. melanderi) by Lynch (1981) and Lynch et al. (1980). P. faisonensis is active during the warm months of the year, and its nests are abundant in the forest litter. The species is timid, and is often displaced from food sources by other ant species.

Genus Prenolepis Mayr

The ecology of P. imparis, the single North American representative of this Holarctic genus, has been studied in some detail (Wheeler 1930, Talbot 1943, Lynch et al. 1980). The species is widely distributed and locally abundant in humid, wooded areas, and is notable for its unusual tolerance of low foraging temperatures.

1. Prenolepis imparis (Say)

At the SERC site this ant is most active in the cool-weather months of spring (March - June) and fall (September - November). Workers are rather deliberate in their movements, and are easily recognized in the field by virtue of the shiny, sharply pointed gaster. P. imparis forms large mobilizations at concentrated food sources such as carrion, fallen fruits, and sap running from tree wounds. Workers are capable of ingesting very large volumes of liquid food, which is stored in the distensible gaster. P. imparis is highly aggressive toward other ant species. The nest, which is placed directly in the ground, often has many separate entrances that extend over an area of several square meters. The species occurs in forested areas from southern Canada through the U.S. into central Mexico, where it is found only at high elevations.

Genus Lasius Fabricius

Three species of this Holarctic genus have been collected at the SERC site, and a fourth (L. flavus) is known from the Chesapeake Bay region. Members of the genus are relatively small, generalized formicines which show varying tendencies toward adaptation for subterranean existence. Of the three local species, L. umbratus is the most fossorial, L. alienus the least, and L. neoniger is intermediate. All species show a strong attraction to sweet liquids and assiduously tend aphids and other homopterans.

Key to Workers of Lasius Species Known or Expected in the Chesapeake Bay Region

(Source: Wilson 1955)

1. Maximum worker eye length 0.20 times the head width or more 2

   Maximum worker eye length 0.17 times the head width or less 3

2. Scape without erect or suberect hairs; in one or both mandibles of a majority of the nest series, either the penultimate basal tooth is markedly reduced in size relative to the two flanking teeth, or the gap between the penultimate and terminal basal teeth tends to be larger in area than the terminal basal tooth and variable in shape; when viewed with the mandibles opened and the head held in perfect full face, the anterior border of the median clypeal lobe is angulate, i.e., formed of two straight sides meeting at the midline to form an obtuse, usually pointed angle ....neoniger*

   Scape with numerous erect or suberect hairs; in all of the workers of a nest series, with rare exceptions, the penultimate and terminal basal teeth are subequal in size, and the gap between them has about the same area as the terminal tooth and is constant in shape; when viewed with the mandibles opened and the head held in perfect full face, the anterior border of the median clypeal lobe describes an even, broad parabolic curve, with sides at least feeble convex and only occasionally meeting in a point at the midline ....alienus*

3. Eyes with six or fewer ommatidia in greatest diameter; female more than twice the length of worker; workers yellow ....flavus

   Eyes with 10-12 ommatidia in greatest diameter; female less than twice the length of the worker; workers pale brown ....umbratus*

1. *Lasius alienus* (Foerster)

This dark brown species is commonest in forested areas, but occurs also in old-fields, lawns, and other disturbed sites. The North American portion of the range includes virtually the entire eastern deciduous forest region and the humid Pacific northwest from northern California to southern British Columbia. The species occurs also in Europe and northern Asia.

2. *Lasius neoniger* Emery

This pale brown species is confined to open, disturbed sites in the SERC area. It tends to be more nocturnal than *L. alienus* in its surface activity and is generally more subterranean than the latter species. *L. noeniger* frequently tends root aphids. The species range extends throughout the eastern U.S. and southernmost Canada west to the Rocky Mountain region, and south to the vicinity of the Gulf Coast, but does not include peninsular Florida or most of Texas and Louisiana.

3. Lasius umbratus (Nylander)

This is the largest and palest of the three Lasius that occur at SERC. The eyes are greatly reduced in size, a reflection of the basically subterranean habits of the species. A variety of wooded and brushy habitats are occupied in the SERC area. The only time when L. umbratus is normally observed above the surface is during its massive mating swarms, which occur in mid-summer. Colony establishment involves temporary parasitism of other Lasius species by L. umbratus queens. The species is widespread in Eurasia and occurs throughout the eastern two-thirds of North America between the latitude of the Maritime provinces and the Gulf states.

Genus Acanthomyops Mayr

The closest relative of this North American genus is Lasius. All Acanthomyops species are light-colored (yellow to pale brown) subterranean insects with greatly reduced eyes and a characteristic lemon-like odor that is immediately noticeable when a colony is disturbed or an individual worker is crushed. The ants of this genus are dependent for much of their food on exudates obtained from subterranean aphids and coccids. All Acanthomyops are thought to temporarily parasitize colonies of Lasius during nest foundation, but the details of this process have not been observed. Five species of Acanthomyops range through the central Atlantic region, but only two have been collected at the SERC site.

Key to Workers of the Genus Acanthomyops Known or Expected in the Chesapeake Bay Region

(Source: Wing 1968)

1. Standing hairs on dorsum of gaster confined to posterior edges of tergites beyond first; Pubescence on gaster dilute, that on head moderately dense; crest of petiolar scale sharp in side view, emarginate in anterior view ....interjectus

   Standing hairs more or less uniformly distributed over dorsum of gaster, not confined to posterior edges of tergites; Pubescence and petiolar scale varying 2

2. In side view, crest of petiolar scale blunt; entire surface of gula covered by many standing hairs 3

   In side view, crest of petiolar scale sharp to moderate; gula either without hairs or with fewer standing hairs over the posterior 3/4 to 1/2 of its surface 4

3. Standing hairs bristle-like, about twice as numerous on propodeum as elsewhere on dorsum of alitrunk ....murphyi

   Standing hairs longer, more or less evenly distributed over dorsum of alitrunk ....latipes*

4. Pubescence on first tergite of gaster dilute; pubescence on antennal scapes suberect ....claviger*

Pubescence on first tergite of gaster dense to moderately dense; pubescence on antennal scapes appressed to decumbent ....subglaber

1. Acanthomyops claviger (Roger)

This is the commoner of the two Acanthomyops species known to occur at SERC. It has been collected in a variety of forested and open habitats. Mixed mobilizations of this species and Lasius alienus have been observed at baits offered nocturnally, but the species is most typically encountered under rocks, logs, or other surface objects. The species ranges throughout the eastern U.S., but is rare south of Tennessee and North Carolina.

2. Acanthomyops latipes (Walsh)

A few colonies of this species have been collected at the SERC site in clearings within forested areas. The species ranges from coast to coast, but the eastern distribution is mainly north of the Chesapeake Bay Region.

Genus Formica Linnaeus

Formica, the most species-rich ant genus in temperate North America, contains about one-sixth of all North American ant species. These large, abundant ants have long attracted the attention of myrmecologists, with the result that probably more is known about the habits of Formica than of any other group of ants. In the U.S. the genus is most diverse in dry, sunny regions, particularly in the Rocky Mountain area. Five Formica species occur in the SERC area but only two of these are truly abundant. Several other species that range through the Middle Atlantic region are included in the key.

Key to the Subgenera, Species Groups, and Species of Formica Known or Expected in the Chesapeake Bay Region

(Sources: Creighton 1950; Buren 1968b; Francoeur 1973)

Key to species groups of the genus Formica

1. Anterior margin of the clypeus with a median, concave impression which may be narrow and notch-like or broad and shallow .....sanguinea group

Anterior border of the clypeus without a median concave impression, the margin evenly convex or angularly projecting in the middle or rarely with fine irregular serrations 2

2. Antennal scape notably longer than the distance from the middle of the clypeal border to the middle of the occipital border; epinotum much

rounded above with the angle between the basal and declivous faces very poorly marked ....pallidefulva group

Antennal scape shorter than the distance from the middle of the clypeus to the middle of the occipital border or, if longer, the epinotum distinctly angular and not evenly rounded above ..Subgenus Formica ..3

3. Large workers with the occipital border very distinctly concave; the pronotum in profile not evenly convex but with a basal and declivous face that meet in an angle ....exsecta group

Large workers with the occipital border at most very slightly concave, usually flat or slightly concave; pronotum in profile evenly convex not angular 4

4. Females feebly shining or subopaque, never more than 5.5mm in length and never larger than the largest workers; erect hairs on the pronotum of workers, when present, often clavate or spatulate ..microgyna group

Females usually 8mm or more in length and notably larger than the largest workers, but if less than 8mm and no larger than the largest workers, then very smooth and shining; erect hairs on the pronotum of the worker, when present, not notably clavate or spatulate 5

5. Bicolored species, the head and thorax ferrugineous or yellowish red and notably lighter than the gaster, or, if infuscated, the infuscation not completely masking the ferrugineous ground color in the large workers; frontal area usually shining, frontal lobes strongly divergent behind ....rufa group

Concolorous species or if bicolored the thorax lighter than the head and gaster; frontal area usually opaque, frontal lobes at most moderately divergent behind, often parallel ....fusca group

A. sanguinea group

1. Erect hairs of alitrunk and gastric dorsum short and bristle-like of the same diameter for greater part of length, then either truncate or abruptly tapering to a fine point 2

Erect hairs longer and flexuous, gradually tapering from base to finely pointed apex throughout the whole length; head and thorax sordid yellow-red or brown; head narrow; eyes extend to margin of head viewed in full face ....pergandei

2. Thorax "saddle-backed"; petiole with blunt crest; mandibles weakly striate and shining; gaster usually brown; dorsum of thorax entirely devoid of erect hairs or with a few erect hairs on pronotum only; head and thorax ferrugineous ....subintegra*

Thorax of usual shape in the subgenus; crest of petiole sharp and sinuate; mandibles strongly striate; gaster black; dorsum of pronotum, mesonotum, and usually epinotum with conspicuous erect hairs ....rubicunda

B. pallidefulva group

1. Anterior face of the petiole strongly convex, both from side to side and from base to crest; crest of the scale blunt and evenly rounded above with no trace of an angular upper edge schaufussi*

   Anterior face of the petiole moderately convex from side to side, seen in profile the sloping upper portion of the face forming a distinct angle with the perpendicular lower portion; crest of the scale distinctly angular above and usually with a bladelike upper edge 2

2. Color clear golden yellow, the gaster little or no darker than the thorax, its surface feebly shining pallidefulva pallidefulva

   Head and thorax yellowish brown to piceous the gaster notably darker, its surface moderately shining pallidefulva nitidiventris*

C. exsecta group

1. Dorsum of promesonotum with at least two dozen conspicuous erect hairs; erect hairs on the lower edge of the pronotum and on the fore coxae long and numerous; erect hairs on the gaster present on all surfaces; deep red head and thorax with black gaster, the anal region of which is reddish ....exsectoides

D. microgyna group

1. Front and vertex of the head with several coarse, conspicuous, erect hairs present; erect hairs on dorsum of epinotum and the crest and sides of the petiole and on occipital corners difficilis

E. rufa group

1. Middle and hind tibia with many erect hairs on all surfaces (color of minor workers dirty yellow-brown) ....obscuriventris

   Erect hairs on middle bud hind tibia, when present, confined to flexor surface (head and thorax of workers red-brown) ...integra*

F. fusca group

1. Color black or brown-black, with yellowish pilosity and pubescence ....subsericea*

1. Formica integra Nylander

This aggressive species is easily recognized by its clear red head and thorax. It forms large, active colonies in exposed sites, particularly

old-fields. F. integra, like other members of the rufa species group, is thought to be a temporary social parasite of other Formica species, but direct evidence on this point is lacking. The species ranges through most of eastern North America from the Maritime Provinces to northern Georgia and Alabama.

2. Formica subsericea Say

This is the only black Formica in the Chesapeake Bay region. The species is associated with wooded habitats, but nests are generally placed in light gaps, edge situations, or other places where sunlight reaches the ground. Colonies are most active in late spring and early summer, at which times they may pile large amounts of soil and plant debris over the nest. The range includes most of eastern North America from the Maritime Provinces and southern Ontario south to Florida, Alabama, and Arkansas.

3. Formica pallidefulva Latrielle

This brown or golden yellow species is the common Formica of old-fields, roadsides, and other exposed habitats in the Chesapeake Bay region. It nests directly in the ground, often in areas of sparse vegetation, and forages actively both on the ground surface and in shrubs and trees. The species ranges from southern Canada to the Gulf region, and west into the foothills of the Rockies.

4. Formica schaufussi Mayr

This species is similar to F. pallidefulva palidefulva, but can be distinguished from F. pallidefluva nititiventris in the field by its larger size and paler yellowish coloration. F. schaufussi is uncommon at the SERC site, where it appears to be restricted to old-field habitats. The species ranges from New England and southern Ontario south to the Gulf region and west to Wisconsin, Iowa, and Texas.

5. Formica subintegra Emery

The single nest of this species that has been discovered at the SERC site was beneath a rock in rather dry, open forest. The colony contained many workers of Formica subsericea, a species that is frequently enslaved by F. subintegra. The latter species ranges through eastern North America from New England and southern Canada to North Carolina, and west to Iowa and Wisconsin.

Genus Polyergus Latreille

All species in this Holarctic genus are obligate slave-makers, and the spectacular slave raids of Polyergus on Formica species have been studied by numerous European and American observers. The mandibles of Polyergus workers are modified into tong-like structures that serve to puncture the integument of other ants, but which are relatively inefficient for carrying food or tending brood. Accordingly, Polyergus is dependent on its slave workers, which are reared from captured larvae and pupae. One of the two North American species occurs in the Chesapeake Bay region.

1. <u>Polyergus</u> <u>lucidus</u> Mayr

This blood-red species has been taken both in old-field and forest-edge habitats at the SERC site. The species ranges throughout the eastern U.S. west as far as the Rocky Mountains.

Glossary

Abdominal Pedicel -- Elongate one or two segments that connect the epinotum and gaster (Fig. 1, pe).

Alitrunk -- The middle of the three major body sections in ants; often termed the "thorax" by non-specialists, but actually consisting of the true thorax and a fused abdominal segment, the epinotum (Fig. 1, at).

Antennal Fossa -- Craterlike depression surrounding the insertion of the antenna (Fig. 1, af).

Antennal Scape -- Greatly elongated basal segment of the antenna (Fig. 1, as).

Antennal Scrobe -- Elongate depression or groove on the head for reception of the antenna (Fig. 1, sc).

Antennal Pedicel -- Segment between the scape and the flagellum, the "elbow" of the antenna (Fig. 1, ap).

Apex -- The part farthest from the center of the body (i.e., most distal).

Appressed -- Flattened, or lying close to (Fig. 2).

Carina -- Crest, ridge, or keel.

Cloacal Orifice -- Circular or slit-like opening at the apex of the gaster (Fig. 3).

Clypeus -- Platelike sclerite on the lower part of the anterior surface of the head, above the mandibles (Fig. 1, cl).

Cosmopolitan -- Essentially worldwide in distribution.

Declivous -- Sloping downward.

Denticulate -- With tooth-like projections.

Diastema -- A gap between the mandibular teeth.

Dimorphic -- Having two well-differentiated morphological forms within a single sub-caste, without connecting intermediate morphs.

Epinotum -- The first true abdominal segment, which in ants is fused to the thorax to form the alitrunk; sometimes called the propodeum (Fig. 1, ep).

Epinotal Spines or Teeth -- Paired projections on the epinotum that extend dorso-posteriorly from near the meeting of the basal and declivous faces in some Myrmicinae (Fig. 1, es).

Fenestra -- Window-like opening or perforation in a structure (Fig. 4, fe).

Flagelliform -- Whiplike antennal shape.

Flagellum -- Portion of the antenna distal to the scape and pedicel (Fig. 1, fl).

Foveolus -- Minute pit-like depression in the integument.

Funiculus -- Distal portion of the antenna, consisting of the pedicel and flagellum (Fig. 1, fu).

Gaster -- The terminal major body section of ants, consisting of the distal seven or eight true abdominal segments (Fig. 1, ga).

Gula -- The posterior surface of the head.

Holarctic -- Distributed at northern latitudes in both the eastern and western hemispheres.

Lamina -- Keel-like projection.

Major Worker -- The largest worker subcaste in dimorphic or polymorphic ants; sometimes called a "soldier".

Maxilla -- One of the paired mouth-part structures immediately postero-ventral to the mandibles.

Maxillary Palp -- Segmented, paired, feeler-like sructures arising from the maxilla (Fig. 1, mp).

Media Worker -- In polymorphic ants with three or more worker subcastes, an individual belonging to the medium-sized subcaste(s).

Median Lobe (of Clypeus) -- Central portion of the anterior border of the clypeus.

Mesoepinotal Suture -- The transverse seam or groove that divides the middle (mesonotum) and posterior (epinotum) portion of the alitrunk (Fig. 1, ms).

Minor Worker -- The smallest worker subcaste in dimorphic or polymorphic ants.

Node (of Petiole) -- Bump-like or scale-like dorsal proojection on the petiole (Fig. 1, np).

Occipital Lobes -- Posterior lateral corners of the head (Fig. 1, ol).

Occipital Margin -- Posterior margin of the head (Fig. 1, om).

Ommatidium -- One of the facet-like individual visual units that make up the compound eye of arthropods.

Pectinate -- Branched or comb-like.

Pedicel -- The one or two reduced segments between the alitrunk and the gaster (Fig. 1, pd).

Petiole -- In ants, a pedicel formed from a single segment, or (in Myrmicinae) the anteriormost of a two-segmented petiole (Fig. 1, pe).

Piceous -- Shining brown-black in color.

Polymorphic -- Having several morphologically distinct forms within a single subcaste.

Postpetiole -- In myrmicine ants, the posterior segment of the pedicel (Fig. 1, pp).

Promesonotal Suture -- Transverse seam or groove that divides the anterior (pronotum) and middle (mesonotum) portions of the alitrunk (Fig. 1, ps).

Promesonotum -- Anteriormost segment of the alitrunk (Fig. 1, pm).

Pubescence -- Minute, appressed hairs on the body or appendages (Fig. 2).

Ruga -- A minute wrinkle or ridge-like structure.

Rugose -- Having a wrinkled or corduroyed appearance due to presence of numerous rugae.

Scape -- The greatly elongated basal segment of the antenna (Fig. 1, as).

Seta -- A relatively long, stout hair (Fig. 2).

Shagreened -- Finely textured, non-reflective.

Subpetiolar Process -- Keel-like projection from ventral surface of the petiole (Fig. 4, fe).

Suture -- Line-like seam marking the juncture of two body segments.

Tibial Spur -- Pointed structure which projects from the distal end of the tibia, near the tarsal insertion (Fig. 1, ts).

Tuberculate -- Covered with minute bumps or projections.

Vertex -- The top of the head below the occiput and above the eyes and the front.

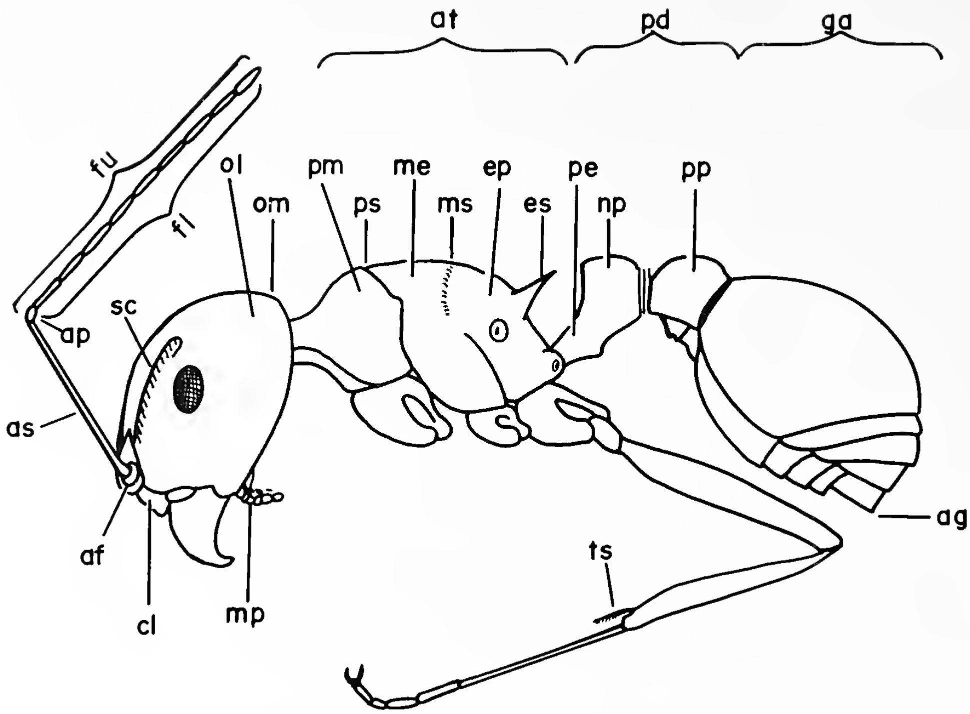


Figure 1. Generalized diagram of an ant worker, showing main external anatomical characters used in taxonomic keys. Abbreviations refer to terms defined in the Glossary.

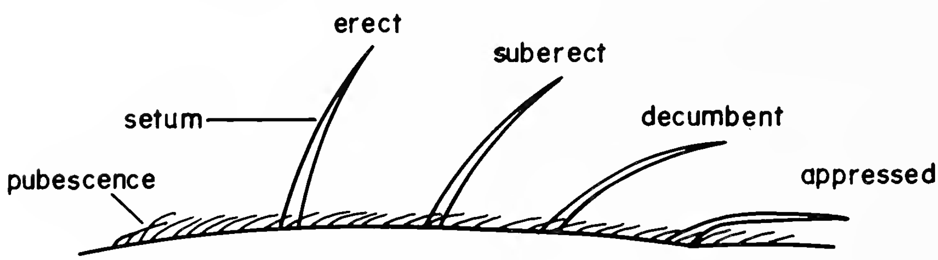


Figure 2. Categories used in description of pilosity in ants. See Glossary.

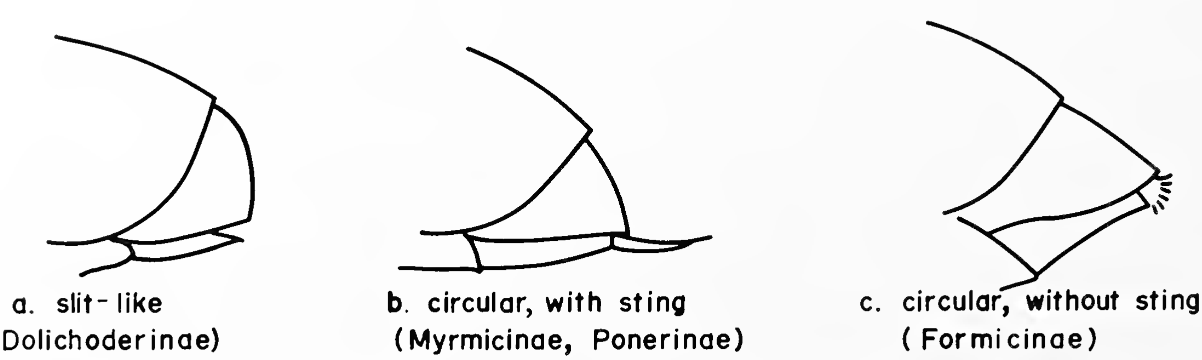
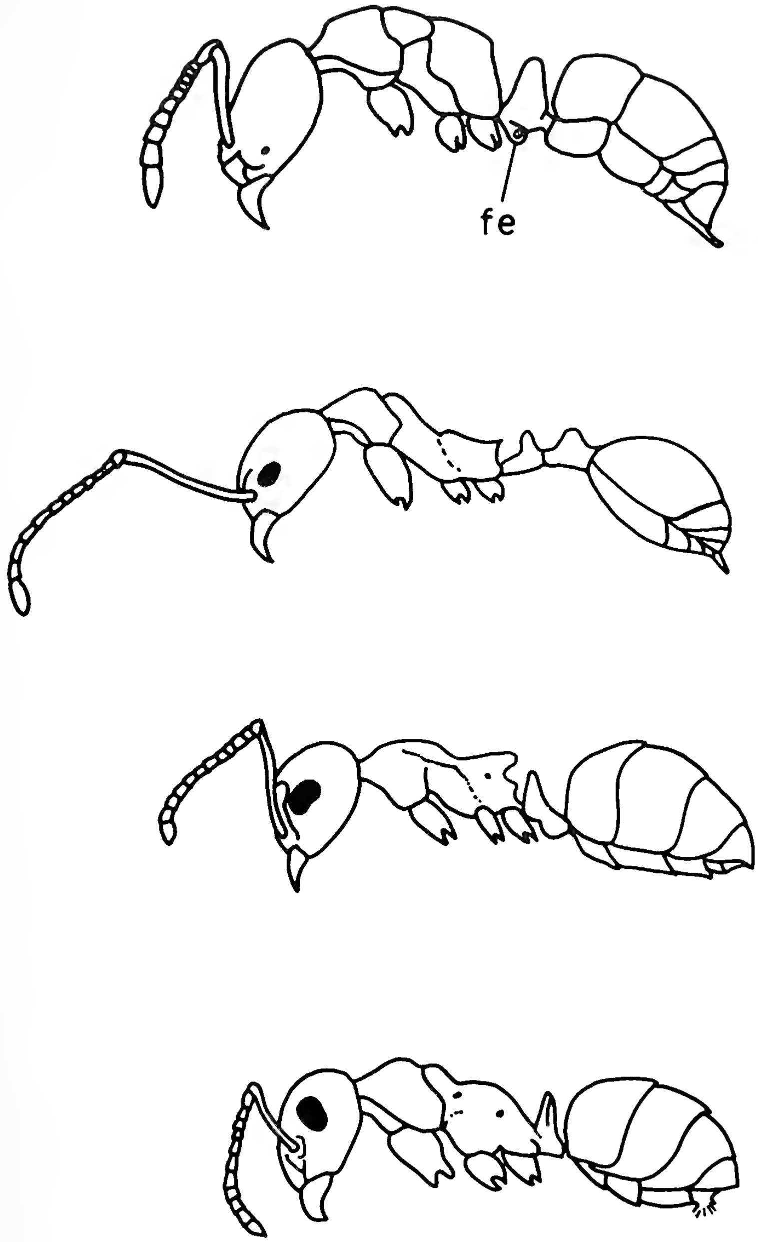


Figure 3. Morphology of cloacal region in the four major subfamilies of ants.



a. Ponerinae (Ponera)

b. Myrmicinae (Aphaenogaster)

c. Dolichoderinae (Dolichoderus)

d. Formicinae (Formica)

Figure 4. Typical workers in the four subfamilies of ants that occur in the Chesapeake Bay region.

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The Fisher (*Martes pennanti*), A Loner from the West

James C. Pack and Peter S. Jayne

The mountain men in early American history are often portrayed as loners. They lived solitary lives and traveled widely in search of game, furs or other riches. There is another loner that occurs in the western mountains of Maryland and eastern mountains of West Virginia that once disappeared, but recently has returned.

That loner is not a "Grizzly" Adams, but a member of the weasel family. It has been called a black cat, but it obviously is not. It is most often called a fisher although it does not fish. How the fisher acquired this name is not known, but it may come from northern trappers who noted its fondness for fish used to bait traps.

In general terms, the fisher is a weasel-like animal with a bushy, strongly tapering black tail and low, rounded ears. Its color varies from dark brown to black with tawny gray-tipped hairs showing on the head and shoulders of older males. Total length for a male is 34-40 inches, including a 13-15 inch tail, with a shoulder height of 10-11 inches. The male usually weighs 7-12 pounds although a record of 20 pounds has been reported. Females are about one-third smaller and weigh about half as much.

The fisher is found only in North America. It is the largest member of its genus, which also includes the marten (*Martes americana*). The animal is secretive in nature, and being a loner is its characteristic behavior, except during the spring breeding season when males run with females. Spring (April) is the time of birth, and also the mating season. The female gives birth to one to four young, then, shortly after their birth, she leaves the den to mate. The female has a protracted pregnancy, the gestation period lasting 350-358 days.

Fishers eat a variety of foods. Food studies have not been conducted in Maryland or West Virginia, but based on food habits reported elsewhere, red squirrels, flying squirrels, mice and other small mammals are important food items. Fishers have been observed feeding on carrion in West Virginia, a behavior also reported in other states. Birds, berries, and insects have also been shown to be components of their diet.

Fishers are known to be active both by day and night. They are at home on the ground or in trees. They use a variety of temporary shelters and sleeping sites, including hollow logs, tree cavities, brush piles and burrows or dens of other animals.

In pioneer days, the fisher made its home in the Southern Appalachians as far south as Tennesee. Destruction of habitat by clearing and heavy logging along with unregulated trapping caused its disappearance in this southern portion of its range.

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As mentioned earlier, our loner has returned home. During the winter of 1969, 23 fishers were obtained from New Hampshire by the Wildlife Division of the West Virginia Department of Natural Resources. Fifteen were released on Canaan Mountain in Tucker County, and 8 were stocked in Pocahontas County, West Virginia (Figure 1).

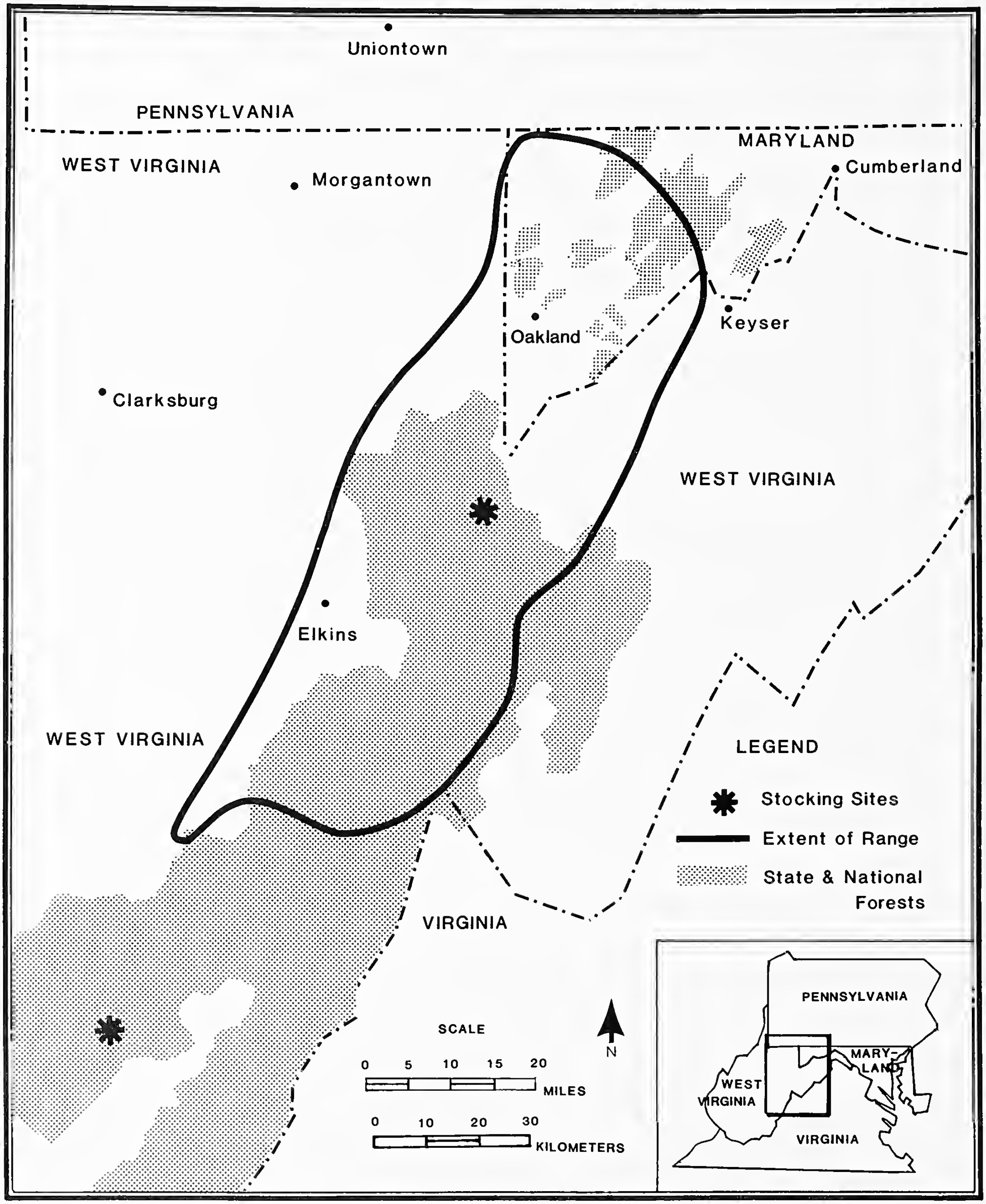

Figure 1. Map showing original release sites and present known range of fisher in West Virginia and Maryland.

Upon completion of stocking, West Virginia wildlife biologists began collecting information on observations and animals trapped. In March 1969 one fisher was killed by an automobile in Tucker County and in June a young kit was found in Grant County. This "ferocious" animal ate hamburger, drank milk and was very playful. Eight other observations were made during 1969, all in the vicinity of the two release sites. In 1970, a West Virginia fisher was taken illegally and the pelt sold to a fur dealer. During the winter of 1972-73 sightings increased and the first verified legal trapping of a fisher occurred in West Virginia. Mapping observations and trap locations placed the minimum range at approximately 2,000 square miles. None of these records were in the vicinity of the southern stocking site and it was assumed that that effort failed.

The first Maryland observations came during the winter of 1974-75, when a biologist verified fisher tracks in Garrett County. The first Maryland specimen was taken in 1977 when a Garrett County trapper caught an adult in the vicinity of Mountain Lake Park. That location was over 20 miles from the Canaan Mountain release site in West Virginia.

Since 1972, fishers have been legally trapped every year in West Virginia and a record 15 fishers were harvested during the winter of 1985-86. With the exception of 1980 and 1983, fishers have also been legally trapped every year in Maryland. Maryland's record harvest of 7 occurred during the winter of 1984-85. Last winter 11 were taken in West Virginia and 5 were trapped in Maryland.

The harvest trend indicates that our fisher population is expanding. The expansion is slow, due perhaps to the relatively limited area of suitable habitat. Fishers need areas of multi-storied forest with relatively large overstory trees. Fishers prefer a combination of deciduous and coniferous trees. In West Virginia and probably also in Maryland, the sugar maple-beech-yellow birch and red spruce stands are the preferred forest types.

The approximate local range of 2,000 square miles demonstrated in the early 1970's has not changed to any significant extent in recent years. Unconfirmed sightings far from the known range are reported every now and then, but most fisher harvests still occur in the vicinity of the Monogahela National Forest in West Virginia, and in Garrett County, Maryland. It is noteworthy that this fisher population has been reestablished nearly 300 miles from the rest of its presently known range. This is a wildlife management success story, and indicates that barriers to the expansion of the fisher can be circumvented by moving animals to suitable habitat. Perhaps other southern states will one day investigate the potential of returning this valuable furbearer to other areas of its original range.

It appears that West Virginia and Maryland are not going to be overrun with fishers, but even in pioneer days they probably were not overly abundant because of limited habitat in this area. We probably won't see this animal frequently,

but it will add to our enjoyment of the environment if perhaps someday we do cross its path. On the other hand, even for those of us that may never see a fisher, it is comforting to know that they are with us again.

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The History and Mineralogy of the John Diggs Mine, Carroll County, Maryland

Fred J. Parker

The John Diggs Mine, one of the earliest copper mines in Maryland, was recently visited. The heavily overgrown site is located on the north bank of Little Pipe Creek between Middleburg and Union Bridge in Carroll County, Maryland. The extent of the remains of this historic mine, and the mineralogy of the locality are described below.

History

Records indicate the John Diggs Mine was operating as early as October of 1742 (Flater unpublished , Anonymous 1952). In 1742 John Diggs petitioned the General Assembly of Maryland to exempt up to fifty workers from the payment of levies, military training or service, clearing of highways, or working in the fields, for the purpose of mining copper. At that time, the mining of copper ore and the making of copper was considered "advantageous" to the inhabitants of Maryland and to Great Britain (Anonymous 1952). How long mining continued is unknown. However, all work was curtailed before the Revolutionary War (Flater unpublished) and there is no record of subsequent activity. Despite the historical and potential mineralogical significance of this mine, mention of it is absent from the works of Ostrander and Price (1940), Pearre (1964), and Heyl and Pearre (1965).

The Site Today

In the late 1940's about 200 feet of mine tunnel were reported to be still accessible (Anonymous 1952). Today, however, virtually all the tunnels are collapsed, and all underground workings are sealed. About 100 feet from Little Pipe Creek, and just upstream from a small waste rock dump is a prominent rock ledge on the hillside into which the mine tunnels were apparently driven. One feature, presumably a tunnel entrance, is still visible although it is obscured by a large mound of debris. On top of the hill a shallow depression about 75 feet long and 6-8 feet wide is also visible. That depression heads in a roughly east-west direction from the apparent mine entrance, and must represent a section of collapsed tunnel. Other such depressions, as well as exploration pits and other evidence of primitive mining are apparent on the hilltop. These testify to the large amount of mining work done at this site in the eighteenth century.

Descriptive Mineralogy

The presence of copper at this site probably resulted from regional volcanic intrusions which occurred along the east coast during the Triassic Period. Many small copper deposits are located near such extrusions along the northeast Atlantic coast, and were mined during the 18th and 19th centuries. Examples include the Griggstown Mines (Somerset Co., New Jersey), American Mine (Somerset Co., New Jersey), Schuyler Mine (Essex Co., New Jersey), Theodora Mine and surrounding prospects (Fairfax Co., Virginia), and several sites in Davidsonville, Montgomery Co., Maryland (Bernstein 1980). The volcanic basalts contained copper that travelled into surrounding country rocks in metalliferous solutions. These solutions deposited copper as oxides, sulfides, or rarely as

native metal. Groundwater containing dissolved acids and gases (for example CO_2) altered the primary minerals to form secondary minerals such as malachite, azurite and chrysocolla.

Additional copper deposits in the Triassic sedimentary rocks of northern Maryland are reported by Ostrander and Price (1940). Chrysocolla was found in red sandstone between Middleburg and Big Pipe Creek in Carroll County, and on the north bank of Double Pipe Creek near Detour, Frederick County. The latter locality also contains native copper, cuprite, malachite, azurite and quartz crystals. Disseminated chalcocite and malachite in Triassic sandstones were prospected near Taneytown in the early nineteenth century (Heyl and Pearre 1965). Ostrander and Price (1940) also reported bornite in slate near Taneytown.

Apparently unrelated copper deposits are also present in Paleozoic Age rocks of Carroll and Frederick Counties. Mining of these deposits was carried out in the past near Libertytown, New London, Johnsville, Sykesville, Louisville (Mineral Hill) and Finksburg.

The dumps of the John Diggs Mine consist primarily of grey to white arkosic sandstones, and dark grey shales. The sedimentary rocks are part of the New Oxford Formation of the Triassic Newark Series. Evidence of fossils in the form of poorly preserved carbonized plant remains is present. Surfaces of sandstone covered with small (to 3 millimeter), clear quartz crystals are common. On these surfaces, and throughout the sandstones and shales are blue and green secondary copper minerals. Although they are very common as smears, coatings and small masses, these copper minerals accounted for a very small volume of the total rock. Small massive, black metallic grains, presumably chalcocite, are also found. The nature of the minerals in these dumps suggests a low grade ore deposit, or that rich ore veins were carefully and efficiently removed during mining by the manual methods of the eighteenth century.

The secondary copper minerals found on the dumps have been visually identified as light blue coatings and botroydal masses of chrysocolla and coatings or flat radiating sprays of green malachite. From a collector's point of view, the botroydal chrysocolla associated with, and often partially coating, forests of small, clear quartz crystals are very interesting and unusual for the northeast U.S. As no other specimens from this locality have been observed by the author in local mineral collections, it is difficult to determine the true specimen potential of the John Diggs Mine locality. Judging from the specimens collected on this visit, the site is certainly capable of producing copper mineral specimens of mineralogical interest to the collector.

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INFORMATION

The Maryland Naturalist is a quarterly publication of the Natural History Society of Maryland. Subject matter includes all areas of the natural history of Maryland and adjacent states. Suitability of manuscripts will be determined by the editor. All accepted manuscripts will be reviewed by appropriate specialists prior to publication. Address all manuscripts and correspondence (except that relating to subscriptions) to Editor, The Maryland Naturalist, Natural History Society of Maryland, 2643 North Charles Street, Baltimore, Maryland 21218. Information relating to subscriptions, or purchase of back issues or other society publications should be directed to the society Secretary at the address given above.

Manuscripts submitted for consideration should be typed, double spaced, on good quality bond paper with adequate margins. Authors should adhere generally to the Council of Biology Editors Style Manual. However, individualilty and readability of writing style are encouraged.

Contributions other than short notes should include a brief informative abstract. Payment of page charges is not required for publication in The Maryland Naturalist. However, if funds are available, assistance to offset publication costs would be welcome.

Subscription to The Maryland Naturalist comes with membership in the Natural History Society of Maryland.

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Arnold W. Norden, Editor

Cover Illustration: The Red Squirrel, Tamiasciurus hudsonicus, a species that was apparently more wide-spread in Maryland during the 1800's than it is today. Original illustration by R.S. Butsch, courtesy of the North Carolina State Museum of Natural Sciences.

Growth Rates Of Exotic Larches In Maryland's Piedmont Plateau[1/]

John B. Genys

Introduction

Larches (genus Larix spp.) are deciduous coniferous trees of the northern hemisphere. Three species are distributed in North America, two in Europe and five in Asia (Rehder 1947, Schoenike 1961). One species, called Tamarack or American larch, L. laricina K. Koch, is native to the eastern United States, and its southern range extends to Maryland's Garrett County. Unfortunately, this species is mainly adapted to wet sites, grows slowly, and is not recommended for use in broad-scale plantings. Much more valuable are some exotic species that grow rapidly and develop into large sized trees. Among them are Japanese larch, L. leptolepis (Sieb. and Zucc.) Pilger, European larch, L. decidua Miller, Western larch, L. occidentalis Nuttall, and Siberian larch, L. sibirica Lebed. Less known are Dahurian larch, L. gmelini (Rupr.) Kuzeneva, and other species from eastern Asia.

The most planted and most studied larch species in the United States and Europe are L. leptolepis and L. decidua (Baldwin 1966: Genys 1960, 1968, 1972: Harman and Genys 1970: Hattemer 1968: Langner and Stern 1965: Stairs 1966). Japanese larch has a small range of distribution on Honshu Island, Japan, and is genetically less variable than European larch that grows at various elevations in Central and Eastern Europe (Genys 1960, 1972). There is general interest in planting more larch trees in the Maryland area because of their rapid growth rate. Maryland plants up to 100,000 Larix trees each year. Consequently, it is important to select the best species and geographic strains, which would adopt well to the new environment and, in a shortest rotation period, would yield the largest volume of wood. Success in achieving this goal has been reported from New York (Cook 1955). This experiment was designed to compare the growth rates of four species and one hybrid of Larix in Maryland's Piedmont Plateau.

Materials and Methods

In 1961, 15 seedlots of larches were obtained from various sources in Europe, Asia and North America. They represented Japanese larch (5 sources), European larch (5 sources), a hybrid (F2) of L. decidua x leptolepis (European x Japanese larch), Siberian larch, Dahurian larch, and 2 sources of Western larch.

1/ Contribution No. 1880 of the Appalachian Environmental Laboratory, CEES, University of Maryland, Frostburg, Maryland 21532

Nursery stock (1-0) was grown and studied at Maryland's Buckingham Nursery near Baltimore, in 1962. On March 23, 1963, a field experiment was established on the public watershed land near the artificial Liberty Lake in Carroll County, Maryland. This site is a former farm field, exhibiting the typical rolling landscape of the Piedmont Plateau. The elevation is about 150 m, and the growing season is about 160 days. The sources were arranged in four complete randomized blocks. Each source in each block was represented by a square 4-tree plot, with individual trees spaced at 1.7 x 1.7 m.

While in the nursery, the seedlings were studied with respect to the date of terminal bud-set, leaf-retention in winter, and one-year heights. Heights were also measured in the field at four years after planting (Genys 1968). This report includes data on survival and heights of 13-year old trees measured in the fall of 1974. Two sources of L. occidentalis failed, leaving 13 different sources for height comparisons. Also, one block of trees was adversely affected by wild hardwood sprouts and became useless. Analysis of variance (using plot-means as items) was based on 38 degrees of freedom for "total", 12 for "source", 2 for blocks, and 24 for interaction. Correlation analysis was used to determine the relationship of height to age, and its relationship to other studied characteristics.

Results

Survival

Survival rates of different 13-year old larch sources varied from 0% to 92% (Table 1). One source of Western larch from Montana failed completely, and one source listed in Table 1 included only one surviving tree of sixteen planted. Also, Dahurian larch from Asia and European larch from the western Alps showed poor survival (33%). All sources of the Japanese larch and most sources of European larch, however, showed good survival. The most outstanding population in survival were L. leptolepis from Yataugake Mountain in Japan (83%), and L. decidua from Poland and a plantation in Denmark (92%). In general, rapidly growing sources showed better survival than slow growing sources (r = 0.49).

Heights

Heights of all 13-year old larch sources averaged 8.4 m (27.6 feet). The four L. leptolepis sources varied in height from 8.4 m (source from a plantation in Denmark) to 10.2 m (from Yataugake Mountain in Japan). Nearly similar in height were European larches, ranging from 7.1 m (the western Alps source) to 8.9 m (from a plantation in eastern Germany). Dahurian and Siberian larches grew slower, attaining heights of only 6.6 m and 6.2 m, respectively. Hybrids of L. decidua x leptolepis (F_2) grew larger than any of the studied sources of pure L. decidua.

Heights at age 13 were significantly correlated with the heights at age 1 ($r = 0.56$, $P < 0.05$) and at age 5 ($r = 0.77$, $P < 0.01$). This suggests that some rapidly growing populations could have been identified on the basis of early measurements. Another indicator for prediction of growth rate could have been the date of terminal bud-set by 1-year old trees. The sooner the buds were set by 1-year trees, the smaller were the 13-year old trees, and vise versa (r = 0.86, sign. at 0.01 level).

Table 1. Performance of larches studied 12 years after planting (1963-1974) in Carroll County, Maryland.

Seed Lot No.	Species and seedlot origin	Elevation M	13-year Survival %	Height real M	Height % M
	L. leptolepis (Japanese larch)				
59	Yataugake Mountain, Japan	1500	83	10.18	121
60	Kamashiroyama, Japan	1800	75	9.63	115
58	Fuji Mountain, Japan	1600	58	9.09	108
61	Okunikko, Japan	1400	67	8.61	102
183	Plantation in Meylgaard, Denmark		75	8.38	100
	L. decidua x *leptolepis* F_2				
258	Plantation in England		75	9.05	108
	L. decidua (European larch)				
248	Plantation in Jaegersbord, Denmark	---	92	8.70	108
184	Plantation in Bautzen, E. Germany		50	8.89	106
185	Wroclaw, Poland	110	92	8.59	102
19	Plantation in Silver Lake, W. Va.	---	75	8.33	99
105	Western Alps (France?)	---	33	7.05	84
	L. gmelini (Dahurian Larch)				
160	Shansi, China	1900	33	6.57	78
	L. sibirica (Siberian Larch)				
249	Trees in Horsholm, Denmmark	---	75	6.19	74
	L. occidentalis (Western Larch)				
159	Flathead County, Montana	1500	8	----	---
The least significant difference for p = 11 at .05 level			56	2.42	29
F-value			3.9	4.83	4.83

Fig. 1. European larches near Silver Lake, West Virginia (22 m high at 28 years of age), parent trees of source #19 which showed about "average" growth rate in comparison with other larches. The progeny of Japanese larches from the Yataugake Mountain grew 22% taller.

Discussion

This experiment confirmed that Western larch is not a tree for silviculture in central Maryland, although it is outstanding in its native Rocky Mountains. Only one L. occidentalis tree survived of 32 planted. Much more outstanding were various sources of Japanese and European larch, and their hybrids. Most of them showed a good survival and grew 9 to 10 meters in 13 years. The most rapidly growing L. leptolepis came from Yataugake Mountain (Japan) and the most outstanding L. decidua were from the natural range in Poland and from two plantations. The studied lots of Dahurian and Siberian larch grew slowly and can not be recommended for broad-scale planting in this area.

This and other research suggests that Japanese larch is an outstanding tree for planting in Maryland. This species has a small natural range, and has shown only a moderate genetic variability (Genys 1972). Consequently, there is less possibility of failure because of poor seed source. However, it is very important to select certain strains of European larch. This species includes many outstanding sources (like those from Poland), but also some very poor sources (like those from high elevations in the western Alps).

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A Brief History of the Natural History Society of Maryland

Haven Kolb

It has been suggested that readers of the revived Maryland Naturalist might desire to know something about the background of the organization that publishes the journal. In the introductory page of the first issue of Volume 31, the present writer gave a brief account of the history of the journal itself; herewith is a similar account of the publishers, the Natural History Society of Maryland.

Interest in the "natural sciences", in distinction to mathematical, historical, philological and other forms of knowledge, has had a rather chequered career in the Baltimore region. As early as 1797 an organization that included such an interest was founded there. It had a brief existence. A generation later another organization appeared; it too met an early end. Baltimore was a thriving city and bustled with energy, but its prosperity was commercial and the interests of its citizens centered primarily, though certainly not entirely, on mercantile affairs. Later in the nineteenth century an organization that endures today was founded, the Maryland Academy of Sciences.

The Academy had some active researchers among its members in the latter part of the nineteenth century, notably Phillip Uhler, still remembered as a leading student of Heteroptera. It also published a set of transactions. However, by the 1920's the organization had greatly declined in vigor. Dissatisfied with the situation, a small group of Academy members founded and incorporated The Natural History Society of Maryland in 1929. It is this institution that publishes The Maryland Naturalist.

The use of the word "Maryland" in the title of this and many other organizations, past and present, deserves a brief comment. The geography of Maryland is such -- a state seemingly cut out to exhibit the maximum of geological, topographical, and meteorological diversity in minimum of area -- that centrifugal forces always dominate centripetal. The western end of the state barely escaped being cut off from the rest at the three-mile isthmus at Hancock. The eastern part, while not cut off, particularly during the long heyday of water transportation, nevertheless developed its own distinctive culture. And, especially during this century, the burgeoning of Washington has caused a large area to be dominated by federal rather than by state concerns. Hence many Maryland institutions, including the one about which we are writing here, are really representative primarily of the north central part of the state, of which Baltimore is still the hub. Would that it were not so, but it is.

The intent of the founders of the Natural History Society of Maryland was, as the name implied, to concentrate on certain aspects of natural science only. Even at the time, its name had a certain quaintness, but it derived from the model of the New York institution to which some of the founders had ties. The fields that the founders aimed to cultivate were also exemplified in the activities of the Philadelphia Academy of Natural Sciences. Essentially the interests of the members were focused upon the occurrence and distribution of the living things found in the state, the geological and mineralological background in which they live and the archaeological remains from the pre-European human inhabitants. The amassing of collections to illustrate these interests was the principal activity of the members and reporting on this activity was a major function of the publications that the new Society soon began to produce.

During the first ten years of its existence the members of the Natural History Society acquired a headquarters building, filled it with natural history collections, and wrote (and, with a few exceptions, produced on their own mimeograph machines) a larger number of publications. Toward the end of the period the Society, by arrangement with the City of Baltimore, completely re-furbished an old building in Druid Hill Park and turned it into a natural history museum that was modest in extent, but thoughtful in design and, in any case, the only such public museum the city had. This museum endured about 35 years.

The outbreak of the second World War curtailed the activities of the Society and modified their nature, but it did not interrupt the flow of publications. Although the war's end brought back many active workers, the in-house production of publications ceased. The weekly gathering of members at the headquarters building declined in attendance as new sources of entertainment and intellectual stimulation developed. Interests changed. Collecting of specimens did not decline, but attention shifted to ecological rather than taxonomic problems. There was an increasing specialization in interests. This resulted in the founding of new organizations, notably the Maryland Ornithological Society, which for several years had its headquarters in the building of the Natural History Society.

In 1960 the opportunity to move the headquarters arose. The old location was threatened by "urban renewal" construction. A new building was acquired along one of the main thoroughfares of the city and not far from the Homewood campus of the Johns Hopkins University. The amount of available space was reduced by the move but upkeep expenses were also reduced and accessibility was greatly improved. When the city authorities decided to devote the Druid Hill Park museum building to other purposes, the collections and exhibits housed there also had to be fitted into the headquarters building. Nevertheless, space was found for a

small meeting room. And the monthly lectures that date from the very beginning of the Society have continued without interruption to the present day.

In the past thirty years other special interest organizations in the fields cultivated by the Society have arisen, such as ones in archaeology, entomology, conchology, herpetology, and paleontology. Some have survived and some have not; none have their own headquarters and so, while avoiding many expenses, must depend upon other organizations for meeting space. One such organization should be mentioned in particular. Since its beginning, the Maryland Herpetological Society has been closely associated with the Natural History Society. It meets in Natural History Society headquarters, curates the herpetological collections of the Department of Herpetology, maintains its membership through the Natural History Society office and publishes its journal through that office.

As this is written The Natural History Society of Maryland is in its sixtieth year. In addition to its collections in herpetology, mineralogy, ornithology, mammalogy, entomology, conchology, botany, paleontology, and archaeology -- all primarily of Maryland -- the Society maintains a library, its lecture series, and an occasional newsletter. Now it is gratifying to have The Maryland Naturalist revived. And all of this is accomplished by a band of devoted volunteers, assisted by one one-day-a-week employee.

Natural History Society of Maryland, 2643 N. Charles Street, Baltimore, Maryland 21218.

Wm. H. Fisher's *Mammals of Maryland*: A Previously Unknown Early Compilation of the State's Fauna

David S. Lee

In the mid 1970's I chanced upon a work listed in the catalogue of a used-book dealer as "Notes on the Mammals of Maryland, Wm. H. Fisher. 1895. 98p." When it arrived, I was disappointed to find only a photocopy of an unpublished, and incomplete, typed manuscript. After quick purusal the "book" was shelved and basically forgotten.

Over a decade later I again happened upon the manuscript while hunting for records of Star-nosed Moles and was surprised to find two locality records for Maryland that were unknown to recent workers (Lee 1987). That prompted a careful reading of the manuscript, and I found that it contained a number of interesting records, some quite important to our understanding of the mammal fauna of Maryland. Therefore, it seems appropriate to publish this historically important manuscript. In order for readers less familiar with the state's mammals to appreciate the importance of some of Fisher's accounts, I have added annotations where appropriate.

My copy is a single-spaced, typed manuscript, uncovered (except for a title page) and consisting of 98 photocopied, hand-cut pages measuring 8½ x 6 inches. The title page and index (table of contents) are unnumbered, and page numbers had not been assigned to the "index." The pages are stapled together along the left margin. The text is copied here verbatum except that several hand written notes, assumed to be those of the author, are not included because they contain no new information, and many are not completely legible.

This interesting manuscript appears to be the first attempt to characterize Maryland's mammal fauna. Although there is no introduction, the inclusion of records from all sections of Maryland and a "Hypothetical List" makes it obvious that Fisher had intended all of the state and its total mammal fauna as his area and focus of coverage. While Fisher's unpublished effort is dated 1895, the first published comprehensive listing of the mammals of Maryland was made in 1950 by Marshal C. Gardner (1950a, 1550b), but this was never completed. In 1969 John L. Paradiso published "Mammals of Maryland" in the North American Fauna series, providing the first and only completed publication on the mammals of the state. Neither of these authors was aware of Fisher's work. While it is easy to see how Fisher's unpublished "notes" remained obscure, it is interesting that some of the information compiled by Fisher was never uncovered by others.

William H. Fisher is relatively unknown, and I can find no published obituary, but we do know that he published a few notes on Maryland birds (Fisher 1892, 1895, 1896). Brooke Meanley (personal communication) considers Fisher one of the state's three pioneer ornithologists. According to Meanley, Fisher lived in Rowland Park in Baltimore in the 1930's and was a good photographer. Although Meanley had visited Fisher several times, he was not aware of his interest in mammals. In several places in his manuscript, Fisher refers to information he obtained from various local naturalists. Some of these men were well known for their interest in birds and mammals. Among the more familiar were William Palmer, C. Hart Merriam, and F. C. Kirkwood. Frank Coates Kirkwood wrote the first "List of the Birds of Maryland," which was published in 1895 (the year of Fisher's manuscript), and in it he acknowledges the ornithological contributions of his Baltimore friends, the first named being William H. Fisher. Thus, Fisher was closely associated with the natural history students of his period. He was familiar with the collections of the Maryland Academy of Sciences, and it is safe to assume he was a member of that organization. From this and the anecdotal statements in Fisher's mammal accounts, we know he lived in the north Baltimore area. Several statements in the text suggest he was from a well-to-do family, and spent a considerable amount of his leisure time hunting in the Dulany Valley region of Baltimore County.

Fisher provides accounts of 59 species of mammals and, with the exception of seals, entirely omits reference to marine species. Thus, he more or less documented 90% of the fauna that Paradiso (1969) reported 74 years later. Many of Fisher's species accounts lack detail, and a good many provide no particularly useful information, even by 1895 standards. The "notes" are simply a compiled collection of information that Fisher was able to uncover. Perhaps most interesting are the historical references to extirpated species, for Fisher was closer in time to those records than are the zoologists who began working on the mammals of the state in the 1950's and 1960's (Gardner 1950a,b; Mansuetti 1950; Paradiso 1969).

Fisher had obviously put some effort into compiling his "notes." From the text we learn that he had been working on this manuscript since at least 1893 (Meadow Vole and Eastern Cotton-tail accounts). His effort is probably best represented by the relative completeness of the volume. If we include the hypothetical species later discovered in Maryland, Fisher missed only 17 terrestrial mammals of the 65 now known from the state. This number becomes more impressive when one realizes that three or four of the species are recent invaders or introductions (Sika Deer, Nutria, Coyote, Spotted Skunk), and seven were not described as full species until the year the manuscript was completed or later: *Sorex fumeus* (1895), *Sorex dispar* (1896, not discovered in Maryland until 1952), *Sorex hoyi* (1910), *Myotis subulotus* (1897), *Myotis sodalis* (1928), *Sylvilagus transitionalis* (1895, not discovered in Maryland until 1972), and *Mustela nivalis allegheniensis* (1901). See also footnote #9. Thus, there were only eight species described in Fisher's time that eventually would be added to his 1895 list. These are mostly small, boreal forms with restricted distribution in Maryland: *Sorex palustris* (unknown from Maryland until 1984, records unpublished), *Peromyscus maniculatus* (the race *nubiterae* of the southern mountains was described in 1896), *Napaeozapus insignis*, *Spilogale putorius* (a species that apparently expanded its range north to Maryland and Pennsylvania earlier in this century [Paradiso 1969]) and *Microtus chrotorrhinus* (1987,records unpublished).

Another species with a restricted distribution in Maryland, *Oryzomys palustris*, also not included, is known only from specialized habitats in the Coastal Plain. All of these omissions further illustrate a general lack of field work on small mammals outside the Baltimore-Washington area. The Long-tailed Weasel (*Mustela frenata*) is the only wide-ranging "large" mammal omitted from Fisher's list. Other missing mammals are bats, but it is not always clear which species Fisher was referring to, even though we can trace back the correct synonyms of his names.

Fisher's notes provide several important pieces of new information. This information is largely in the form of additional records and comments on previous distribution and abundance. Much of this historical information fills a void between the post-Civil War period and when the first published attempts to document the mammalian fauna appeared in the 1950's. Fisher's discussion of specimens or records in the Maryland Academy of Sciences that were not available to later authors is indicative of poor record maintenance by the Maryland Academy. In fact, since the early part of this century, most specimen records of this type have been maintained by the Natural History Society of Maryland.

I thank Eloise Potter and M. K. Clark for reading various drafts of this manuscript. Brooke Meanley provided useful information on Fisher. Charles Potter, U.S. National Museum, checked for Fisher specimens in the National Museum but was unable to locate any.

What follows is Fisher's text. Footnotes marked with symbols are his as they originally appeared. Numbered footnotes are mine, and they appear at the end of the entire text. This way there should be no confusion as to what was in the original text and what I added. A source of confusion is the common and scientific names of the mammals. Some have changed several times between 1895 and the present. I have provided, through footnotes, the currently accepted names for those species with revised nomenclature. Fortunately, except for several bats, there is little question as to what species Fisher was addressing when he compiled his manuscript.

NOTES ON THE MAMMALS OF MARYLAND.

WM.H.FISHER.

1895.

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NYCTICEJUS CREPUSCULARIS LeConte.[1]

Twilight Bat.

Dr. C. Hart Merriam writes me under date December 21, 1893: "A southern species which has been recorded from Pennsylvania and the District of Columbia".

ATALAPHA NOVEBORACENSIS (Erxl.)[2]

Red Bat; New York Bat.

This is our most common bat. During the day they remain hidden in the recesses of old ruins, caves, or hollow trees, and about dusk come forth in search of their food, which consists principally of insects.

Some years ago, at Mt. Washington, Baltimore Co., I discovered what looked like a red ball of about eight inches in diameter, hanging to the limb of a Beech tree, thirty feet from the ground. On throwing a stone, and striking the limb, about twenty or more Red Bats scattered in all directions, and soon disappeared from view. As the time was only about two p.m., they had evidently clustered together to rest for the day.

This species is often seen flying about in the bright sunlight. August 24, 1893, while sitting on the bank at Lake Roland, Baltimore Co., time about 4:30 p.m., I noticed one of these bats, apparently flying with great difficulty. It flew to the side of a Linden tree, and attached itself to the bark. On catching it, I found the membrane of its left wing to be badly torn.

Dr. John D. Godman relates the following anecdote illustrating the affection of this bat for its young: "In June 1823, the son of Mr. Gillespie, keeper of the city square, caught a young red Bat, (Vespertilio Nov-Eboracensis L.) which he took home with him. Three hours afterwards, in the evening, as he was conveying it to the museum in his hands, while passing near the place where it was caught, the mother made her appearance, followed the boy for two squares, flying around him, and finally alighted on his breast, such was her anxiety to save her offspring. Both were brought to the museum, the young one firmly adhering to its mother's teat. This faithful creature lived two days in the museum, and then died of injuries received from her captor. The young one, being but half grown, was still too young to take care of itself, and died shortly after."#

#American Natural History, Vol.1,3rd.Ed.,p.42.

ATALAPHA CINEREA (Beauv.)[3]

Hoary Bat.

This large and handsome bat is rare in our state. In a letter received from Dr. C. Hart Merriam, December 21, 1893, he writes: "The Hoary Bat is found during migration, and probably also in the mountains."

Dr. Merriam says: "The Hoary Bat can be recognized, even in the dusk of the evening, by its great size, its long and pointed wings, and by the swiftness and irregularity of its flight. It does not start out so early as our other bats".#

#Mammals of the Adirondacks,1884,p.176.

VESPERUGO FUSCUS (Schreb.)[4]

Dusky Bat; Brown Bat; Carolina Bat.

Next to the Red Bat (A. noveboracensis), in point of numbers, comes this species. I have often seen them over the back yards in the city, catching insects about the windows of the houses. Over the country roads they are common.

May 30, 1893, while walking through the woods near Glencoe, Baltimore Co., I saw a long strip of loose bark hanging from one side of a dead tree. On pulling this off, twenty five or thirty bats were disclosed, clinging to the trunk beneath it. Some remained there, but the greater number flew away, those remaining seemed to be numb and unable to fly for several minutes. On touching them they would make an effort to fly, and finally they all disappeared amongst the trees.

VESPERUGO NOCTIVAGANS (LeConte).[5]

Silver-haired Bat; Silver Black Bat.

A northern species found in the mountainous parts of the state, and possibly in other sections during migration. It has also been recorded from Washington, D.C.

This bat, like all others, is very fond of flying over water, and according to Dr. Merriam has been known to swim against a strong current on being wounded and falling into the water.

VESPERUGO GEORGIANUS (Cuv.)[6]

Georgia Bat.

This bat is said to be common in Maryland, but I am not familiar with it. It is frequently confounded with Vesperugo fuscus.

VESPERTILIO SUBULATUS Say.[6]

Little Brown Bat.

This bat is very common with us, making its appearance late in the evening. Several times I have found them hanging behind the outside shutters of country houses.

VESPERTILIO LUCIFUGUS LeConte.[6]

Blunt-nosed Bat.

I am not familiar with this Bat, but under date of February 28, 1894, Dr. C. Hart Merriam writes me from Washington: "a common bat in this neighborhood and also, doubtless, in Baltimore".

BLARINA CAROLINENSIS (Bach.)[7]

Short-tailed Shrew; Mole Shrew; Carolina Shrew.

This is our most abundant Shrew, still it is seldom seen. Its habitat is principally in the woods, where most of its time is spent beneath dead logs, leaves, and the roots of trees.

It is said to be a friend to the farmer, as most of its food consists of insects, slugs, worms, etc., a mouse always being an acceptable change.

It is seldom eaten by either hawks or owls, doubtless on account of its strong offensive odor. It is often found on the gound, dead, very likely dropped there by some bird of prey.

Mr. Amos W. Butler, in his paper "On Indiana Shrews," gives an interesting account of a nest of this Shrew found December 13, 1891, by Mr. Charles Dury, of Avondale, Cincinnati, Ohio. He says: "I went to an old orchard, and under the first log rolled over I discovered a nest x x x made of small bits of the leaves of the Sycamore tree, lined with grass fibres, and situated in a hole or pocket excavated in the ground. I lifted the nest into the sifting net and sifted it over a sheet of white paper, and was overwhelmed at the result. The fine debris was a jumping, crawling mass of insect life, beetles, fleas, ticks and larvae. I gathered and bottled 106 Leptimus, and many ran over the edge of the paper and escaped. There were over a hundred large vicious looking fleas, most energetic biters (as I discovered from those that secured a lodging in my clothing). How a mouse could live in such a den is a mystery."#

#Proceedings of the Indiana Academy of Sciences,1891,p.162.

BLARINA CINEREA (Bach.)[8]

Ash-colored Shrew

This diminutive Shrew is common with us, but like all others of its species its habits are such that it is seldom seen.

It is found principally in the open fields.

SOREX PERSONATUS Geoff.[9]

Common Shrew.

A very diminutive animal, and said to be quite common.

SCALOPS AQUATICUS (Linn.)

Common Mole; Shrew Mole.

An abundant, and well known species, being generally found on higher ground than the Star-nosed variety, which has a preference for low moist situations.

Their burrows can be seen running in all directions on almost any lawn in the country. The Moles are often trapped by placing a dead fall over their burrows, in such a way to fall as the animal passes. Dr. Merriam says: "Its food consists almost wholly of earth-worms, grubs, ants, and other insects that live in the earth and under logs and stones."#

Speaking of the nest of this species Audubon says: "We had an opportunity on two different occasions of examining the nest and young of the Shrew Mole. The nests were about eight inches below the surface, the excavation was rather large and contained a quantity of oak leaves on the outer surface, lined with soft dried leaves of the crab-grass, (Digitaria sanguinalis). There were galleries leading to this nest in two or three directions. The young numbered in one case, five, and in another nine."†

#Mammals of the Adirondacks,1884,p.153.
†Quadrupeds of North America,Vol.1,1856,p.90.

CONDYLURA CRISTATA (Linn.)[10]

Star-nosed Mole.

This species is not so abundant as the Common Mole. Its habits are said to be about the same, but it is found in lower and more swampy ground.

Dr. C. C. Abbott says he has seen their burrows with the opening beneath the surface of the water, and he knows from personal observation that the animal is an excellent swimmer."#

Among specimens in the Maryland Academy of Sciences, is one secured by Otto Lugger in October 1878, near the boat lake in Druid Hill Park.

May 28, 1879, Dr. H. H. Hopkins sent four young ones from New Market, Frederick Co.

#A Naturalist's Rambles about Home,1885,appendix,p.449.

FELIS CONCOLOR Linn.[11]

Cougar; Panther; Puma; American Lion; Painter;
Catamount; Mountain Lion.

The Panther was once abundant, but is now very rare; possibly still found in the mountains.

At times they are very destructive to the farmer, killing large numbers of sheep and calves. They are said to be very cowardly, seldom venturing to attack man.

In regard to the distance a Panther can leap, Dr. C. Hart Merriam writes: "The distance that a Panther can pass over in a single leap is almost incredible. On level ground a single spring of twenty feet is by no means uncommon, and on one occasion Mr. Sheppard measured a leap, over snow, of nearly forty feet. In this instance there were three preliminary springs, and the Panther struck his deer on the fourth. The longest leap measured by Mr. Sheppard was one of sixty feet, but here the Panther jumped from a ledge of rocks about twenty feet above the level on which the deer was standing. He struck it with such force as to knock it nearly a rod farther off."#

Dr. J. Lee McComas, under date March 4, 1876, presented the Maryland Academy of Sciences with two specimens from Oakland, Garrett Co.

#Mammals of the Adirondacks,1884,p.p.31-32.

LYNX CANADENSIS Raf.[12]

Canada Lynx.

More of a northern species than the following. A specimen, formerly in the Museum of the Maryland Academy of Sciences, came from the mountains of Garrett Co. This specimen was seen by Prof. S. F. Baird, and pronounced by him to be *L. canadensis*.

LYNX RUFUS (Gmel.)[13]

Bay Lynx; Wild Cat; Lynx.

At one time the Wild Cat was very common in most parts of our state, but now it is seldom seen, and then only in the wild mountainous regions.

Dr. J. Lee Mc Comas presented the Maryland Academy of Sciences, of Baltimore, with two specimens from Garrett County, under dates, February 8, 1878; March 5, 1879.

Mr. J. R. Ridgely tells me that about the year 1840, on two occasions, he saw one in "Carroll's Woods", Howard County.

One was reported as having been killed somewhere in Prince George's County in 1892, but I have no authentic record of it.

The latest record I have for the state, is one seen and shot at on Backbone Mountain, Garrett County, December 9, 1893, by a hunter named Perry Lee.

CANIS LUPUS Linn.[14]

Common Wolf; Gray Wolf

Once common all over the state; possibly a few still remain in the wildest parts of the mountains.

George Johnston mentions that as late as the year 1724, Benjamin Allen tendered to the court a Wolf's head, and made application for the bounty on it. He further says: "In 1680 Wolves seem to have been very plentiful in the adjoining county of New Castle [Del.] for the court ordered 'fifty wolf pits or houses to be made,' and enjoined the constables to see that they were well baited and tended."#

The following adventure of Holmes Wiley, a noted hunter of Garrett Co., is related by Scharf: "While out hunting on a winter day he came upon the tracks of a powerful Wolf. He pursued the animal to its den in a cavern in Negro Mountain. He at once saw it was beyond his reach unless he could follow the beast to its lair. The entrance to the cave was only large enough to allow a man to approach in a crawling attitude. In this manner he felt his way in utter darkness for a long distance, with the reliable rifle by his side, until the glare of the eyes of the enraged animal disclosed its position. A crack from the gun, and in a moment the fierce growl ceased. The old huntsman was too well skilled in forest life to rush upon his game at once, but when he approached it was found to be dead. The leaden missive had struck a vital point, and to his surprise and satisfaction he found six live whelps with the dead mother, all of which were brought forth and scalped, for which trophies he secured one hundred and thirty dollars, under the law as it then stood in regard to the destruction of these animals."*

Mr. W. H. Farquahr states that Wolves were exterminated in Montgomery County shortly after the year 1780.†

#History of Cecil County,1881,p.192.

*History of Western Maryland,Vol.2,1882,p.1520.

†Annals of Sandy Spring,1884, Introduction,p.xxiii.

VULPES FULVUS (Desm.)

Red Fox; Cross Fox; Silver Fox; Black Fox.

Quite common in nearly all sections of the state. Its burrows are frequently seen in the fields and woods, some half dozen of them being within five hundred yards of our home in the country.

On October 9, 1893, about 7:30 a.m., my brother heard some Crows raising a rumpus in the field back of the house. Looking out he saw they were after a Fox which was running across the field. He shot it from the window with his rifle, and found it to be a young female, nearly grown.

In the latter part of the winter of 1881 I was ducking in Dundee Creek, Baltimore Co. The creek was frozen over, but we had a large hole cut in front of the blind for the decoys. While seated with my man, not killing much, we heard some hounds off to the left. In a few minutes a Fox ran out on the ice, and about one hundred yards from the shore sat down to rest and watch for the dogs. These presently made their appearance, and on catching sight of the Fox made a bee-line for it. The Fox ran for the opposite shore and disappeared, with the hounds after it.

In a short time the huntsmen made their appearance on the shore, but in order to follow the hounds they had to go several miles around the head of the creek.

Mr. C. L. Herrick gives the following, in regard to the variations in color of the Red Fox: "In the ordinary variety the general color is a tawny red, rather darker on the shoulders and flanks. The tail hairs are dark tipped; the outside of the legs and back of ears are also black. The under parts including the chin and a space about the muzzle and also the tip of the tail, are white.

"The variations from this pattern are now generally considered to be due to melanism for which no satisfactory cause can be assigned. Complete melanism gives us the Black or Silver-Gray Fox (V. argentatus). In high latitudes often quite black save the tail. Elsewhere this phase consists in a silvery gray coloration of the upper parts.

"Intermediate conditions give rise to the Cross-Fox (V. decussatus) in which the ventral line, muzzle and legs are blackish, with two cross bars on the inside of the legs. The median line above is also dark and is crossed by a dark shoulder band. The head is gray and the sides are marked with fulvous.

"It is authoritatively stated that these so called varieties may be found in the same litter, although to what extent the variations are inherited, is not known."#

#Mammals of Minnesota,1892,p.p.80-81.

UROCYON VIRGINIANUS (Erxl.)
Gray Fox

Not so common as the preceeding species. It does not make as much sport with the hounds as the Red Fox, on account of its habit of taking to a tree when hard pressed.

A specimen in the Maryland Academy of Sciences, came from Montgomery County. J. H. Leopold tells me the gray is the commoner of the two species about "Maryland Heights," Washington Co.

"Quite common in Prince George's County." (A.B. Farnham).

"Not so abundant as the Red Fox in Montgomery Co." (Geo. Marshall).

MEPHITIS MEPHITICA (Shaw.)[15]
Skunk; Polecat.

The Skunk is generally found in open fields, and on account of its being crepuscular, or nocturnal, it is more common than is usually supposed. It is a very pretty little animal, but one that it is best not to get too familiar with.

It often takes up its abode beneath a barn, or other outhouse, and it is not long before its presence is known.

"When away from human habitations, the retreats of the Skunk are underground burrows, the hollows of decayed logs and stumps, the crevices among rocks-in short, any natural shelter not away from the ground."#

In August 1887, while crossing a field in Dulaney's Valley, Baltimore Co., about three p.m., I saw a young Skunk rooting like a hog. It would throw up the earth, and at times stick its nose down and then walk around several times in a circle. After watching it for a time I shot it, but was unable to save the skin.

Dr. C. Hart Merriam says of the Skunk: "He does not evince that dread of man that is so manifest in the vast majority of our mammals, and when met during any of his circumambulations rarely thinks of running away. On the contrary, his curiosity is aroused, and he is full as apt to come towards one as to make off in the opposite direction. He is slow in movement and deliberate in action, and does not often hurry himself in whatever he does. His ordinary gait is a measured walk, but when pressed for time he breaks into a low shuffling gallop. It is hard to intimidate a Skunk, but when once really frightened he manages to get over the ground at a very fair pace."*

Mr. F. C. Kirkwood saw one June 7, 1891, in Dulaney's Valley, Baltimore Co.; he says: "Coming home down the rocky bed of the run, I nearly walked on top of a Skunk that was drinking at the time. I got back a short distance to watch it. It remained still and looked at me for fully a minute, then leisurely turned around, and as leisurely walked up the bank and disappeared in the bushes."

They are very prolific, having it is said, two litters of young each year, with from seven to nine at each litter.

In Lawrence Co., Pa., is a skunk farm owned and operated by a man named John Eckman, and it is said he makes a good living by a raising the animals and selling their pelts. In the "Baltimore American" of November 7, 1894, is a very interesting account of the way in which he keeps his pets.

#Fur-Bearing Animals,Dr. Elliott Coues,1877,p.218.
*Mammals of the Adirondacks,1884,p.71.

PUTORIUS ERMINEA (Linn.)[16]
Ermine; Stoat; White Weasel.

This Weasel is by no means common, and is the only one we have in the state. The male, (which is smaller than the female), is frequently mistaken for the Least Weasel, (P. vulgaris.) It is very destructive to poultry, but also does an immense amount of good by destroying large numbers of rats and mice.

Audubon says: "Wherever an Ermine has taken up its residence, the mice in its vicinity for half a mile round have been found rapidly to deminish in numbers."#

Mr. Wm. Palmer, of the National Museum at Washington, D.C., tells me that some years ago Mr. O. N. Bryan, of Bryan's Point, Prince George Co., secured a specimen in the white pelage, from his county. This is the only record of the Ermine in its white coat that I can find for our state.

They are very inquisitive little animals, and upon being scared into shelter will almost immediately look out to see what is going on.

J. H. Fisher Jr., tells me that one day while seated on a log in the high grass, where he was watching some birds, a Weasel came out from behind the log and stuck its nose against his leg, but upon his moving, it scampered off into the bushes, and he saw nothing more of it.

They climb trees very readily, and I have no doubt they destroy many birds' nests, and their eggs and young. Mr. F. C. Kirkwood tells me he once saw a Weasel about twenty feet up in a Chestnut tree. A small boy climbed after it, upon which it went up fully fifty feet and then out on a limb, from which he shook it to the ground. It struck hard, but immediately jumped up and was out of sight in an instant.

#Quadrupeds of North America,Vol.2,1856,p.59.

LUTREOLA VISON (Schreb.)[17]
Mink.

Personally, I have only seen the Mink on two occasions, although I have frequenlty seen its tracks in our marshes, and heard of its capture.

"As an enemy to the poultry yard it ranks ahead of the Weasel and all other North American mammals. Furthermore it kills large numbers of fish, x x x its destructiveness in this respect renders it a serious obstacle to the industry of fish culture. Away from the vicinity of man it habitually feeds upon small mammals, birds and their eggs, fish, frogs, turtles' eggs, and the like. x x x Its harmfulness is offset in a measure by the good it does in killing injurious rodents, particularly muskrats and common rats and mice. Hence, although an acknowledged enemy to the poultry raiser and fish culturist, it is a public benefactor in localities where muskrats damage dikes, canals, irrigating ditches, and ponds. At the same time, in the light of our present knowledge, it must be regarded as more injurious than beneficial, at least so far as the farmer is concerned.

"The Mink is remarkably strong for so small an animal, and has been known to drag a Mallard Duck more than a mile in order to get to its hole, where it was joined by its mate."#

While hunting frogs during the early part of May 1889, in Hog Creek, a small branch of the Gunpowder River, I saw what at first sight I took to be a Muskrat swimming across the stream, but when near enough I saw it was a Mink. I shot at it with a small rifle but missed it, and it swam to the bank and ran off in the cat-tails. I sat still watching, and in a few moments it came out from the marsh and started to swim across the creek, followed by three young, nearly grown.

I shot one of these and the others immediately dived, coming up close to the shore and escaping into the grass. I watched for sometime longer, hoping to secure the old one. Occasionally I caught a glimpse of her peering out from behind some old roots, where I have no doubt she had her den, but I was unable to get a shot at her. On examining the one I had shot, I found it to be fairly alive with fleas.

They are said to bring forth five or six young to the litter, usually in April. Their nests are placed either in burrows or in hollow logs.

They are very persevering in pursuit of their prey, and frequently track it by scent. F. C. Kirkwood tells me that when in Queen Anne's Co., during March 1893, in snow six inches deep he saw the tracks of a Rabbit followed by those of a Mink, but after tracing them for some distance they were lost in a dense tangle of Green-brier.

Mr. W. S. Clayton, Green Spring, Md., sent an albino female to the Maryland Academy of Sciences.

Mr. A. B. Farnham writes me from Prince George Co., January 27, 1894: "Quite common; have taken ten this season."

#Report U.S. Dept. of Agr. (Rept. O & M),1888,p.p.488-489.

LUTRA HUDSONICA (Lacep.)[18]

Otter; Canada Otter.

At one time very common, but seldom seen now. As they have been extensively trapped for their fur, they are nearly exterminated in our state.

They are great destroyers of fish, and if a pair take up their abode near a fish pond they will soon deplete it.

About March 1881, I was in a ducking blind on Dundee Creek, Baltimore Co., when an Otter swam back of the blind, and in towards the shore. I did not see it until too late to shoot, so I watched to see what it would do.

It swam to the marsh and climbed out on the bank, about two hundred yards from my blind, and after remaining there for about a quarter of an hour it plunged into the water and swam off, disappearing behind a point of land.

Shortly after this, two men were crossing Bird river about three miles from Dundee Creek, and saw an Otter swimming across. They went after it and struck at it with an oar, upon which it turned on them, and tried to climb into their boat. I don't remember if it succeeded in getting in, but they finally killed it.

J. H. Leopold tells me they used to be very plentiful along the Potomac River, near Weverton, but they are seldom seen there now; the last one he has record of being one he caught in a trap during the winter of 1890-1.

Mr. J. R. Ridgely says he often saw their "slides" near Ellicott City, Howard Co., about forty years ago, and that the Otter was then frequently seen and trapped along the Patapsco River, and other streams.

Their favorite sport is sliding, and for this purpose they select a high muddy bank, bordering a stream. In speaking of this habit Audubon says: "On one occasion we were resting ourselves on the bank of Canoe Creek, a small stream near Henderson, which empties into the Ohio, when a pair of Otters made their appearance, and not observing our proximity, began to enjoy their sliding pastime. They glided down the soap-like muddy surface of the slide with the rapidity of an arrow from a bow, and we counted each one making twenty two slides before we disturbed their sportive occupation."#

Col. Eph. G. Polk, of Princess Anne, writes me December 17, 1893, as regards the Otter in Somerset Co.: "Otters were once thick here, quite abundant until 40 years ago. They inhabited principally the streams that ran down out of our swamps, which streams were really the heads and sources of the Manokin and Pocomoke Rivers. A colored man named Levin Horsey, who was once a great trapper, fisherman, and turtle catcher, when that paid well, and does a little of it yet in season, saw some tracks in the branch to the north of James M. Dryden's farm winter before last, that he was dead sure were Otter tracks. He said nothing, but set about a dozen traps that day. The next night he caught three fine Otters and the foot of another. The Otter had cut it off with his teeth.

x x x Lev. Horsey never caught the Otter that lost its foot, and has caught no more since, 'though he has set for them. They are very rare here now."

Later, on March 4, 1894, Col. Polk writes me that a few weeks prior to that date, a man living on the Manokin River discovered some fresh Otter tracks in one of the "guts" making up from the river, and followed them until he came to its bed. This bed was said to resemble a Muskrat house. He watched by this for half a day, and finally when he saw the bed moving he plunged his gig into it with all his strength. Immediately there was a great rumpus, and the bed was torn to pieces. He had speared two Otters at once. He had a hard fight with them, but finally succeeded in killing them both.

Mr. A. B. Farnham writes from Prince George Co.: "Rare; have never taken it myself, but it is occasionally seen or trapped".

From Newmarket, Frederick Co., Dr. H. H. Hopkins writes: "The Otter is occasionally trapped during the winter, but they are quite rare now."

Mr. J. R. Ridgely tells me that one was seen several times along the middle branch of the Patuxent River, near his farm in Howard Co., in December 1894.

John D. Johnson, who fishes and traps most of the time about the head waters of the Gunpowder River, caught two Otters during 1894. He says they are very destructive to his nets, tearing them to pieces.

While at "Holly Neck Ducking Shore", at mouth of Middle River, in January 1895, I asked the man in charge if there were any Otters about. "Yes", he said, "there are at present two use in the marsh". He also said he trapped another last spring.

#Quadrupeds of North America,Vol.2,1856,p.8.

URSUS AMERICANUS Pallas.[19]
Black Bear.

There are very few Bears remaining in Maryland, although at one time they were very abundant.

Mr. C. de M. Todd, on his return from a trip to Mountain Lake Park, Garrett Co., in August 1893, said that shortly before his arrival there, a Bear came down from the mountains and wanted to get to the river, but would not cross the railroad tracks. A crowd collected and went after it, but it escaped them to the mountains again.

Farquahr in "Annals of Sandy Spring", says: "The last bear shot in this neighborhood was brought down from the fork of a chestnut tree, a little way north of 'Sharon'; this was in 1780".#

Taken while young, they make interesting pets, being very playful. It is not an unusual thing to see them led through the country by a man, and made to dance and perform in various ways for the amusement of the spectators.

They are exceedingly fond of honey, and never fail to rob a hive when found, not minding in the least the stings of the angry bees.

Sir John Richardson, speaking of the Black Bear says: "Its favourite food appears to be berries of various kinds, but when these are not to be procured, it preys upon roots, insects, fish, eggs, and such birds or quadrupeds as it can surprise. It does not eat animal food from choice; for when it has abundance of its favourite vegetable diet, it will pass the carcase of a deer without touching it. It is rather a timid animal, and will seldom face a man unless wounded, or has its retreat cut off, or is urged by affection to defend its young. In such cases its strength renders it a dangerous assailant. I have known the female confront her enemy boldly until she had seen her cubs attain the upper branches of a tree, when she made off, evidently considering them to be in safety, but in fact leaving them an easy prey to the hunters. The speed of the Black Bear when in pursuit is said not to be very great, and I have been told that a man may escape from it, particularly if he runs into a willow grove or amongst long grass: for the caution of the Bear obliges it to stop frequently and rise on its hind legs for the purpose of reconnoitring. I have, however, seen a Black Bear make off with a speed that would have baffled the fleetest runner, and ascend a nearly perpendicular cliff with a facility that a cat might envy".†

It is reported that a Bear was seen prowling about the wooded sections of the mountains near Frederick, Md., during December 1894. ("Baltimore Sun", Dec. 25, 1894.)

#Annals of Sandy Spring, W.H. Farquahr,1884,Introc.p. xxiii.
†Fauna Boreali Americana, Vol.1,1829,pp 15-16.

PROCYON LOTOR (Linn.)
Raccoon.

The Raccoon is quite common in all sections of our state where the timber is heavy enough for shelter, but it is found in greater numbers in the lower counties.

Their favorite haunts are low wet woods with an abundance of large trees, in the hollows of which they hide during the day, and at night come forth in search of their food which consists of vegetables, fruits, corn, shell-fish, fish, frogs, insects, eggs, small mammals, and birds. In fact the 'Coon is an omnivorous animal.

Their nests are made in hollow trees, and as a rule at quite a height from the ground. Frank C. Kirkwood gives me the following account of a nest he found May 27, 1893, near Reed's Creek, Queen Anne's Co.

"About thirty five feet up in a Chestnut tree a hollow stub stuck up nearly straight. The entrance was about a foot across, but lower down it grew wider. A small knot-hole about two inches in diameter gave light, and by completely closing the upper hole I was enabled to see a large 'Coon rolled up in the bottom, about six feet below my face, and suckling several young about the size of six weeks old kittens. She merely turned her head up and looked at me. Half an hour later she had not moved."

In Somerset Co., they are unusually plentiful. Col. Eph. G. Polk, of Princess Anne, tells me that one day during September 1890, he and his son were out hunting squirrels and came across three Raccoons, (one old and two young), in the same tree, and killed them all. It is not an usual thing to see them abroad during the daytime, although at times they sun themselves in the trees or marshes.

DIDELPHIS VIRGINIANA (Kerr.)[20]
Opossum.

This animal is very common wherever the timber is of sufficient size to afford it a hiding place. It is good eating, and is hunted a great deal with cur dogs; and as it is chiefly nocturnal, the hunt generally takes place at night. Still, it is often found abroad in the daytime: February 2, 1893 while in Dulaney's Valley, Baltimore Co., I found one in a clump of low Willow trees. When first seen it was up one of them, about 10 feet from the ground. It was killed and found to be very thin, probably on account of the severe cold weather and deep snow of about ten days ago.

August 1889, I noticed a path of some animal along a fence back of our house at Ruxton, Baltimore Co., and on setting a steel rat trap, that night I caught a young Opossum.

They are very prolific; Dr. H. H. Hopkins, of New Market, Md., presented the Maryland Academy of Sciences in 1880, with a female and fourteen young.

"An Opossum was caught in a tree at the corner of Stiles and Exeter streets, this city, the other night."#

During the summer of 1893 an albino Opossum was caught near North Point, Baltimore Co.

#Baltimore American, March 4, 1893.

SCIURUS HUDSONICUS Erxl.[21]
Red Squirrel; Pine Squirrel; Chickaree.

Very common; found in almost every piece of woods but seeming to have a preference for evergreen timber.

They are very fond of the cones of the Pine, and I have frequently found the ground beneath these trees littered with fragments where they had been cutting.

It is generally thought they drive off the Gray Squirrels, but the two species are sometimes found cutting nuts in the same tree, and I have commonly found them to inhabit the same woods.

The Chickaree is an impudent little animal. When one catches sight of a person in the wood it sits on a limb and barks and chatters at a great rate. Once when I was after Gray Squirrels, a Chickaree sat in a Hickory near me, and at every crack of my rifle he would switch his tail, and bark and chatter, until at length in order to have quiet I was compelled to shoot him.

This species, like the Flying Squirrel, sometimes takes up its abode in the walls of country houses, and becomes quite a nuisance.

In regard to their nesting Dr. C. Hart Merriam says they sometimes make their homes in holes in the earth, and by excavating beneath stumps, brush piles etc., converting them into secure retreats. The only nests I have found were in hollow trees, or else were open nests built in either the Red Cedar or in wild Grape vines. One of these open nests I found April 23, 1893, was in the top of a small Cedar tree, about ten feet from the ground. It was about 14 inches in diameter, and nicely made of green moss and the inner bark of the Cedar, with a small opening in the side, near the top.

This species is said to destroy both the eggs and young of various birds.

SCIURUS CAROLINENSIS (Bodd.)[22]
Gray Squirrel; Black Squirrel.

The Gray Squirrel is our common squirrel, and is found in more or less abundance in nearly every piece of woodland.

Some years they are much more plentiful than others; in 1891 I saw very few, but the present year, 1893, I have found them to be very abundant in all sections of the state. It is said they migrate from place to place, according to the scarcity or abundance of mast.

The Squirrel is an early feeder, being found abroad soon after it is light. Often when cutting nuts in the Hickory trees they congregate in large numbers. Mr. J. R. Ridgely tells me that one morning when "squirreling" in Howard County, he killed eleven from one tree.

The young, which are usually two, or three, are brought forth in March and April, sometimes as early as February. Mr. F. C. Kirkwood, on February 11, 1894, found an open nest in Baltimore County, which contained three young, only a few days old.

Sometimes the Squirrel brings forth its young in a hollow tree, at other times in the open nest. These nests are made of twigs, and leaves, placed in the crotch of a tree. One found April 13, 1893, was in a Cedar tree, and composed entirely of fresh green Cedar branches, lined nicely with Cedar bark, and with an opening in one side. Often an old nest of the Crow is used by building over the hollow.

During warm days in winter the Squirrels lie in these open nests and sun themselves. December 15, 1892, while shooting in Harford Co., at the report of my gun a Squirrel jumped from a nest in a tall Poplar tree. It tried to reach a "den tree" next to the one it was in, but missed it, and fell about fifty feet to the ground. The shock nearly stunned it, and it lay still for several seconds, then recovering, it ran up the tree and into a hole.

When taken young they make an interesting pet, and become very tame.

The so called Black Squirrel, which is occasionally seen, is only a melanistic form of the common Gray Squirrel. In Queen Anne's Co., it is commonly supposed that when three young are found in the nest, one of them will be black.

They seem to be much more common in some sections than in others, as a rule being most abundant in the mountains. Mr. J. R. Ridgely tells me he has frequently seen them near Hancock, Washington Co., and some years ago I found them to be very abundant in the mountains of Pennsylvania. Col. Eph. G. Polk has occasionally, many years ago, seen a few in Somerset Co.

A Black Squirrel in the Maryland Academy of Sciences, was presented by Dr. J. Lee Mc Comas, October 2, 1875, and was killed near Oakland. Another was secured in one of our markets by F. C. Kirkwood, and came from the same place.

January 1, 1894, while walking through the woods in Green Spring Valley, Baltimore Co., I caught sight of a Black Squirrel as it switched round a tree and ran into its den.

Dr. C. Hart Merriam says both colors, black, and gray, are sometimes taken from the same nest.

December 16, 1893, I secured from a commission house a pure white specimen, with blue eyes, shot near Bloomfield, Talbot Co. Mr. J. E. Tylor tells me he has also had two specimens, in the white pelage, from this same locality.

Mr. F. C. Kirkwood saw a white squirrel while driving in the upper part of Dulaney's Valley, Baltimore Co., July 30, 1894.

SCIURUS CINEREUS Linn.[23,24]

Fox Squirrel; Cat Squirrel.

The Fox Squirrel is much rarer than any of our other Squirrels, and is considerably larger than the Gray Squirrel. Among the notes of the late Edgar A. Small, of Hagerstown, is the following: "Jany.31/82. Stuffed a male Fox Squirrel given me by - Stanhope. It is about 26 inches from tip of nose to end of tail."

They are said to be very clumsy in climbing, seldom taking a long jump from one tree to another like the Gray Squirrel.

Their pelage is subject to a variety of colors; black, red, and gray. One received from Earle B. Polk, Somerset Co., was very silvery in appearance. This "Cat Squirrel" as it was called, was a young one, and was shot on "Beech Ridge." A few days later while shooting in the same place he saw another, but did not secure it.

Mr. J. R. Ridgely says: "In former years they were abundant in Howard Co." He says they are much later feeders than our other Squirrels; seldom making their appearance until after nine a.m.

J. H. Leopold tells me he occasionally kills them in the bottoms along the Potomac River, near Weverton. He says they are more abundant in the bottom lands than in the mountains.

Mr. A. B. Farnham writes me they are uncommon in Prince George Co. November 22, 1893, Mr. F. C. Kirkwood saw one in market, that was shot near Monkton, Baltimore Co.

In September 1892, Earle B. Polk shot one in Somerset Co., that measured 27 ½ inches in length. This one was silvery gray in appearance, which seems to be the prevailing color in that section.

SCIUROPTERUS VOLUCELLA (Pallas.)[25]

Common Flying Squirrel.

These beautiful and sprightly little animals are seldom seen during the day, unless they are driven from their nests in stumps or hollow trees.

As soon as nightfall comes they make their appearance, and you can see them sailing from tree to tree. I remember when I was a boy, an old Chestnut that stood alongside the stable on a friend's place, and how towards dusk we would watch the squirrels "flying" down to the stable roof to get their supper from the grain inside. There were at least twenty squirrels in that old tree; they were never disturbed, but after a time they became a nuisance at the house, as they got into the walls and raised a great fuss chasing and playing about at nights.

Audubon says: "The Flying Squirrels never build their nests of leaves on the trees during summer like the true squirrels, but confine themselves to a hollow, or some natural cavity in the branches or trunk.#

They must have changed their habits in later years, as on June 25, 1892, I found an open nest in a small Cedar tree in the woods near Rockland, Baltimore Co. It was only about five feet from the ground; was made of the inner bark of the Cedar, and contained three young. The mother was quite fearless, allowing my companion to take her in his hands, but then biting him. The young were taken home and made very interesting pets, becoming tame and gentle. As soon as it was dark they would come out from their nest and spin around in the wheel of their cage, each one appearing to try and race ahead of its companion. At times they would cling to the wheel and spin around with it.

They were exceedingly fond of grasshoppers, and when given one they would invariably begin their meal by eating the head, then the legs, and as a rule leaving the body untouched.

The Flying Squirrel is generally very active, and far from awkward, but one I scared from a nest in a low stump, seemed to have great difficulty in making its way over the ground, as if its "wings" troubled it, and were in the way.

May 3, 1893, near Van Bibber, Harford Co., I noticed a small round hole in a dead stump, and on shaking it a Flying Squirrel ran out. I climbed up and had to break out a piece of the wood in order to see inside, and on looking in I found three young, about two days old. The parent was very much concerned, sitting on a dead limb about four feet distant, and occasionally uttering a low squeak.

Replacing the piece of bark broken from the hole, I descended the tree, and moving off about twenty feet I watched to see what the old one would do. She remained perfectly quiet for about two minutes, and then going to the hole she peeped in several times, finally going in and covering her young.

I have never found more than three young in a nest; this seems to be the usual number, although four are often found.

As a rule they confine themselves to nesting in a dead stump, but in 1877, Mrs. F. W. Patterson presented the Maryland Academy of Sciences with a nest built in a lamp shade.

#Quadrupeds of North America, Vol.1,1856,p.221.

TAMIAS STRIATUS (Linn.)

Ground Squirrel; Chipmunk; Chipping Squirrel; Hackee.

A beautiful little striped squirrel, generally seen running along worm fences, and stone walls bordering woods.

Their burrows are made beneath the roots of trees, stumps, or stone piles, and are often found to contain large quantities of nuts, acorns, etc.

I have frequently caught them in a small wire mouse trap baited with a piece of apple, but never found them to make a very interesting pet, as they would not become tame.

F. C. Kirkwood saw one September 2, 1892, eating a large chrysalis.

ARCTOMYS MONAX (Linn.)[26]

Ground Hog; Woodchuck; Marmot.

Common; I have frequently found them in various localities within a few miles of Baltimore, but they appear to be most plentiful north from the city.

August 13, 1892, while shooting in Dulaney's Valley, Baltimore Co., I came across an old female in a tree. She was about fifteen feet from the ground; six feet out from the trunk, in a fork. The tree stood next to a worm fence, and as it slanted slightly, it was easily climbed. The "hog" took no notice of me, making no attempt to escape, and keeping perfectly still and quiet.

Mr. F. C. Kirkwood gives me the following account of one he saw in a tree: "July 4, 1893, in Dulaney's Valley I saw a Ground Hog, half grown, ten feet up in a Pine tree six inches in diameter. As I came up to it, it slowly climbed up, hugging like a small boy until it reached a slight bend with an upright dead twig. Here it lodged, twenty feet at least from the ground.

J. H. Fisher Jr., on June 2, 1893, saw an old Ground Hog and her brood of five young. He was walking, and came on them suddenly. The old one ran into her burrow, followed by all the young but one, which was captured. The mother after getting into her den, stuck out her head and watched Mr. Fisher while he stood there looking at the one he had caught, and which he afterwards released, and allowed to escape into the burrow. The young were about one third grown.

They make their burrows in the ground, sometimes in an open field, with no shelter, at other times beneath an overhanging rock, or the roots of a tree. A favorite place to burrow is beneath a hay-rick. Such a place I know of, has been used by them for years. They are also very fond of old quarries.

August 26, 1893, I came across some half dozen or more of their burrows on the Loch Raven property, in Dulaney's Valley. They were in a hollow, near some low bushes, and these were intersected in all directions by their paths.

Godman says their burrows are formed in the following manner: "The Marmot first throws the earth with his fore paws, under his belly, and when it has accumulated to a certain degree he rests on his fore paws and kicks the dirt forcibly outward with the hind ones, and thus going backwards to the mouth of his den, he finally throws it to a considerable distance from the entrance. x x x The burrows extend to a great distance under ground, and terminate in various chambers, according to the number of inhabitants. In these, very comfortable beds are made by the Marmot, of dry leaves, grass, or any dry soft rubbish to be collected. It is really surprising to see the vast quantity of such material an individual will cram into his mouth to carry off for this purpose. He first grasps with the teeth as much as he possibly can; then sitting erect, with both fore paws he stuffs the mass projecting on each side deeper into the mouth, and having arranged it satisfactorily, takes up successive portions, which are treated in like manner; during the whole time the head is moved up and down to aid in filling the mouth to the very utmost. This is repeated until every fragment at hand is collected, and the whole transferred to the sleeping apartment, into which the Marmot retires towards the decline of the day, and remains there until the morning is far advanced. At some seasons of the year this Marmot is seen out on moonlight nights at a considerable distance from the burrow, either in search of better pasture, or looking for a mate.

x x x "There is no animal so perfectly cleanly in its habits as this Marmot; not only the fragments of its food and the litter of its bed are carefully removed, but the "loose earth about the mouth of its burrow is carefully scraped away.

x x x "The Marmot, as we have already mentioned, eats with great greediness and large quantities. To the wild animal red clover is a very favourite food, and when it can be obtained, lettuce, cabbage, and various other garden vegetables."#

In speaking of the Ground Hogs dislike to water, Dr. C. Hart Merriam says: "As a rule the Woodchuck manifests great antipathy for water. In confinement he rarely partakes of it, and in the wild state his burrows are frequently so remote from it as to preclude the idea of his journeying there to drink. Hence it seems probable that the moisture which his system requires is derived from the juices of the plants on which he feeds, together with the dew or rain that may have lodged upon them.

"Having searched in vain for a record of an instance where a Woodchuck has been known to swim, voluntarily, I take great pleasure in being able to contribute an account of a case that recently fell under my personal observation. On the 12th of June, 1883, while rowing up the Fulton Chain of Lakes, in company with Dr. A. K. Fisher and Walter H. Merriam, a Woodchuck was observed in the water directly ahead of the boat swimming across the channel between Second and Third Lakes. He swam deep, at times the top of his head and the tip of his tail alone appearing above the surface. He crossed from the north to the south shore and was evidently very much fatigued and somewhat confused, for, although I pushed the boat close after him as he was about to emerge, he only partly climbed out upon a small log that extended into the water, and showed no inclination to move off, or even to change his position. He was poked several times with a stick, and finally Dr. Fisher stroaked him with his hand before he became sufficiently aroused to show that he was aware of our presence. We left him standing partly upon the log, with one leg still in the water, shivering, and apparently in a very unhappy state of mind. The animal was young, and was evidently travelling about in search of a suitable place in which to establish his home."†

#North Am. History, J.D. Godman, 1860, Vol. 1, p.p. 327, 329.
†Mammals of the Adirondacks, 1884, p. 248.

CASTOR CANADENSIS Kuhl.[27]
Beaver.

The Beaver has been extinct in Maryland for many years, but according to numerous records it was once a common inhabitant of the state.

Father Andrew White in his "Journal of the Ark and Dove," (1633-1634), enumerates among the native animals of Maryland, "muskrats, beavers, martens, and weasels."

Claiborne's trading post on Kent Island was established chiefly for collecting Beaver skins, and shipping them to Europe.#

Scharf says the Beaver was formerly abundant in the western part of the state," and built dams across the creeks and rivers."*

#Archives of Maryland, 1667, p. 169 and following.
*History of Western Maryland, Vol. 1, 1882, p. 32.

SITOMYS AMERICANUS (Kerr.)[28]
White-footed Mouse; Deer Mouse; Vesper Mouse.

This is the most abundant of the field mice, and is more often seen than any of the other species.

Audubon says: "We do not regard this species as doing very extensive injury either to the garden or farm".#

The White-footed Mouse nests in various situations; under logs, in stone piles, holes in trees, and sometimes constructs open nests, which are generally placed in the midst of a Green-brier thicket. These are composed of moss, the inner bark of the Cedar, or Grape vine, and dead leaves, and are globular in shape. Sometimes they appropriate an old bird nest and build over that, using it as a foundation.

January 2, 1893, I saw some soft material hanging from a small hole in a Wild Cherry tree, and on investigating it I found it to be occupied by a White-footed Mouse.

Dr. C. Hart Merriam says: "It is an excellent climber and I have often found its nest in holes in living trees, "more than seventy feet (21.33 metres) above the ground.

"x x x The White-footed Mouse does not hibernate: Except during the severest weather its tracks may be seen in the snow throughout the winter, its long tail leaving a furrow by which it may always be recognized".†

Mr. C. L. Herrick, in "Mammals of Minnesota," p. 181, and following, quotes an interesting account of the musical capacities of the Wood Mouse, as this species is sometimes called.

#Quadrupeds of North America, Vol. 1, 1856, p. 305.
†Mammals of the Adirondacks, 1884, p.p. 263-4.

ARVICOLA RIPARIUS Ord.[29]

Meadow Mouse; Field Mouse.

A mouse of the open fields and meadows, where its principal food consists of the roots of grasses. During harvest time they are very destructive in the corn fields, taking up their abode in the fodder stacks, and living upon the grain.

Their runways, or paths, can be seen in almost any field. This summer (1893) a family of them made their home beneath some old stumps covered with trellis vine, on the lawn in front of our house, and their paths led from this in every direction.

October 25, 1891, F. C. Kirkwood found a nest of this mouse made in an old Phoebe's nest, under a low bridge, in Dulaney's Valley, Baltimore Co.

ARVICOLA PINETORUM (Leconte.)[30]

Pine Mouse.

This is a common species, but owing to its habits being but little known, it is supposed to be much rarer than it really is. It is said to be very destructive, much of the harm done by it being attributed to other species.

Mr. George Marshall, of Laurel, Prince George Co., writes me: "Quite rare in this locality, I have taken but three specimens in all my collecting".

Mr. A. B. Farnham, of Bennings, Prince George Co., says it is not common in his locality.

Mr. J. R. Ridgely killed one on his farm near Simpsonville, Howard Co., Dec. 21, 1894. He tells me it is the only one he has seen in forty years.

SYNAPTOMYS COOPERI Baird.

Cooper's Mouse.

This is a very rare mouse. One is mentioned as among the stomach contents of a Red-tailed Hawk killed at Sandy Spring, Montgomery Co., March 24, 1890.#

#Hawks and Owls of the U.S., Dr. A. K. Fisher p. 59.

ZAPUS HUDSONIUS (Zimm.)

Jumping Mouse; Labrador Mouse; Wood Mouse.

I have never had the fortune to meet with this species in a state of nature. Mr. F. C. Kirkwood gives me the following note: "November 1, 1891, in Dulaney's Valley, Baltimore Co., along Dance's Run the dogs start a Jumping Mouse. It jumped from stone to stone about two feet, finally jumping three feet, and just missing the bank fell into the stream. It swam well, but with the current, and then crawled out under some dead grass where I lost sight of it".

June 19, 1876, a specimen of this mouse was sent to the Maryland Academy of Sciences, by Edward Stabler, Sandy Spring, Md.

Dr. C. Hart Merriam says: "The agility of these animals is almost incredible. I have repeatedly known them to clear a distance of more than ten feet (a trifle over 3 metres) at a single bound, and their leaps are made in such rapid succession that their feet seem barely to touch the ground. To attempt to catch one when any covert is near is a hopeless task".#

This species hibernates during the winter. It is usually found in old grain fields, and grassy meadows.

#Mammals of the Adirondacks, 1884, p. 291.

FIBER ZIBETHICUS (Linn.)[31]

Muskrat; Musquash.

Very common in the river marshes, lakes, along canal banks, and streams; in fact they are found in almost every piece of water of a suitable size.

On the Eastern Shore of Maryland, every year from December to March, they are extensively hunted and trapped for their fur, as well as their flesh, which is eaten to a great extent by the country people.

"Its usual home is a long burrow opening beneath the surface of the water and passing many yards into the bank, terminating in a cosy nest beneath the projecting roots of a tree. It is here the young are reared. x x x

"Like the Beaver it builds itself a cabin, but of less perfect construction, and takes up its abode near the side of some piece of water."#

They will eat almost anything in the vegetable line, but are especially fond of the white roots of the water rushes, which they scrub and wash before eating. They are also fond of the fresh water mussels, (Unio), the shells of which can often be found near the entrance to their burrows.

In August 1893, the water in Lake Roland, Baltimore Co., was about twelve feet below its normal depth, and exposed many burrows in the banks. In examining them I saw where the Rats had carried large quantities of mussels into them, the shells being scattered about the entrances, and over the bottom of the Lake.

They are very destructive animals about a dam, as they will undermine the breast-work, an illustration of which was seen in November 1893, when they started a leak in one of the dams of the Chesapeake & Ohio Canal.

Some years ago, when living at Mt. Washington, Baltimore Co., a pair located in our ice pond and burrowed into the bank, and breast of the dam. I set a steel trap, and the next morning found I had captured the female. I spied the male, off about twenty five yards in a corn-field, and went after him. When he saw me coming he started to run, but finding he was not able to escape he turned and ran at my legs, when I killed him.

At times, when skating, I have seen them swimming beneath the ice, and have followed above them until I would drive them into their burrows.

J. H. Fisher Jr., tells me that May 11, 1893, at Van Bibber, Harford Co., he saw a Muskrat about six feet up in an inclined Willow tree, overhanging the water.

In February 1893, a pure white Muskrat was killed on Chester River.

"An Anne Arundel Co., hunter recently killed 333 Muskrats while on a hunt lasting three days."*

"Mr. Hynson Cole, of Double Creek, Kent Co., has killed during the last winter 130 Muskrats and 15 Minks."†

#Mammals of Minnesota, 1892, p.p. 212, 216.
*Baltimore Sun, March 11, 1893.
†Baltimore American, March 7, 1893.

MUS DECUMANUS Pall.[32]

Brown Rat; Norway Rat; Common Rat.

Jordan says this species was introduced about the year 1775.#

It is a great pest, and is found almost everywhere.

The following incident will illustrate the ferocity of the common rat when caught in close quarters. One night I had occasion to go into my kitchen after the servants had retired upstairs, and as I opened the door I heard several rats scamper across the floor.

I lighted the gas, and began to hunt them with a poker. I caught two in the closet, and killed one. The other, a very large one, ran out and got in a corner by the door. When it saw me coming after it, it tried to run past me, but finding it could not do so, it sprang at me, jumping about two feet high, and to the distance of about four feet. It did this twice before I succeeded in killing it.

Speaking of the rat, Dr. C. Hart Merriam says: "Rats are good swimmers, and in their migrations from place to place (which are usually performed at night, and thus escape notice) they do not hesitate to swim rivers and ponds that lie in the way. Though chiefly nocturnal, they are often seen in the daytime.

"They are excessively prolific, commonly bringing forth from seven to twelve young at a birth, and having several litters each season. Some idea of the number of Rats inhabiting large cities may be had from the fact that, at Paris, in a fortnight's time, more than six hundred thousand were killed in the sewers. Their skins were manufactured into kid gloves."*

In choosing a location for their nests they generally burrow beneath a building, pile of lumber, or some similar place, but at times they deviate from their usual habit.

Mr. J. R. Ridgely mentions the fact of a nest, found by him on his farm in Howard County, that was placed in the natural cavity of a leaning Apple tree, and about five feet from the ground. It contained seven young.

#Manuel of the Vertebrates, Prof. David S. Jordan, 1880, p. 31.
*Mammals of the Adirondacks, 1884, p. 260.

MUS MUSCULUS Linn.
House Mouse; Common Mouse.

An exotic species well known in all households.

I have often heard of singing mice, but never had the good fortune to hear one until this season (1893), when one made its appearance in my walls and remained from May until December, shortly before Christmas being the last time it was heard.

The first night of its song I got up and looked into the chimney thinking a young swallow had fallen from its nest. Its voice at times would sound like the rippling of water, and again it would trill like a Canary.

I have never heard it outside the walls, but could hear it moving along the length of the room singing as it went. Knocking on the walls instead of causing it to cease singing, would rather increase the volume of sound, and rapidity of its song.

April 28, 1881, a black specimen was caught in the city by Mr. P. Hornick, and presented to the Maryland Academy of Sciences.

LEPUS SYLVATICUS Bach.[33]
Gray Rabbit; Common Rabbit.

Common in all sections of the state, but more plentiful in the lower counties, where they find abundant shelter in the thickets and around the edge of the marshes.

It is great sport hunting them with Beagle hounds, and they are the staple game of the Dutchman. On a holiday large numbers of sportemen are seen on the early trains, on their way with their dogs to the "necks" in the neighborhood of Gunpowder and Bush Rivers.

It was said that many Rabbits were killed by the excessive cold and heavy snows of January 1893, and it was feared they would be very scarce this season, (1893-4), but during a short walk in Dulaney's Valley, Baltimore Co., August 26, 1893, I started three, and a great many have been killed by the gunners this season.

April 13, 1891, while out Snipe shooting I saw a large Red-tailed Hawk flying close to the ground and making frantic dashes at some animal running through the tall grass, and presently I saw a Rabbit run across an open space. The Hawk paid no attention to me, but on being stung with a load of #10 shot, it flew away.

Lewis says: "The American Hare x x x x breeds about three times in the course of a year; in the south they may possibly, owing to the effects of climate, bring forth more frequently. Their nest is of the rudest character, and constructed with little or no care for anything like warmth or comfort; it is generally found upon the open ground, in an old field, perhaps protected somewhat from the weather and easy observation by the overhanging leaves of a shrub or other small plant."#

A nest which I found some years ago, was merely a hollow scratched in the open ground of the lawn to one side of our house, and lined with the animal's own fur.

As a rule they move about more, and feed at night; during the day sitting motionless for hours at a time in their "forms" under some bush or brush pile.

Their flesh is good eating, and during season can always be found exposed for sale in the markets.

#American Sportsman, Elisha J. Lewis M.D., 1885, p. 387.

LEPUS AMERICANUS VIRGINIANUS Harlan.[34]

Southern Varying Hare; White Rabbit.

Rare in the state; occasionally found in the mountains.

In the Smithsonian Report for 1868, page 57, is the record of a gift by Dr. J. Lee Mc Comas of a skin of this species from Maryland. In reference to it, Mr. G. Brown Goode wrote to me September 26, 1893: "The specimen to which you refer is not in the collection at the present time.

"It was identified by Dr. Coues as L. americanus, var. virginianus. There is, in Mr. True's opinion, no reason to doubt this identification, as it is known that L. americanus ranges south to Virginia.

"Referring to this species Prof. Baird said: 'Southward it is common as far as the northern counties of Pennsylvania, and extends along the Alleghany range into Virginia. It is not rare along the summit level of the Baltimore & Ohio Railroad'."

A specimen (12478) in the U.S. National Museum, came from Cumberland, Allegany Co.

Mr. George Marshall writes me he saw one that was killed about two miles west of Laurel, Prince George Co., during Christmas week in the early seventies. He says the color was pure white, the ears being mixed with gray at the base, then gray to the tips.

ERETHIZON DORSATUS (Linn.)[35]

Canada Porcupine.

Rare in Maryland, seldom wandering so far south, although it has been recorded from the mountains of Virginia.

A specimen from Garrett Co., was presented to the Maryland Academy of Sciences, by Mr. W. S. Thompson, June 15, 1874. It was mounted and placed on exhibition in a large case in the Museum of the Academy, but it was at length nearly destroyed by the moths which entered the case.

CARIACUS VIRGINIANUS (Bodd.)[36]

Virginia Deer; Common Deer; Red Deer; White-tailed Deer.

The Virginia Deer is still abundant in some parts of the state, but is not found in such large herds as in former years.

Mr. J. R. Ridgely once saw nine feeding together on a hillside near Hancock, Washington Co. They were about three hundred yards from a much used public road.

While I was fishing near Weverton in October 1893, J. H. Leopold the veteran fisherman, hunter, and trapper, told me that a short time before, three young Deer were caught in a fence corner in Allegany Co. One died, but the remaining two were then alive.

From the Baltimore Sun, of November 23, 1892, I copied the following: "On yesterday afternoon Josiah Wolff brought to Oakland a fine four prong buck, weighing one hundred and eighty pounds."

Among the notes of the late Edgar A. Small, of Hagerstown, is the following: "Jany. 8/82. Stuffed and mounted the head of a male Virginia Deer. It is the finest head I ever saw, the hair is much darker and redder than usual. Shot near Green Spring Run."

CERVUS CANADENSIS Erxl.

American Elk; Wapiti.

The Elk formerly ranged down the Alleghany region, and into Virginia. They are known to have once inhabited Maryland, many traditional names being connected with them.

Elk Ridge, in Howard Co., is said to have once been a favourite ground for them, many years ago.

PHOCA VITULINA Linn.[37]

Harbor Seal; Common Seal.

A wanderer from the north; sometimes coming into Chesapeake Bay.

Several years ago a Seal was seen in the vicinity of Fort Mc Henry, in the harbor of Baltimore, and I have no doubt it was this species. There was mention made of it in one of the local papers, but I have not been able since then to find the account, although I saw it at the time.

Another remained in our harbor for several days during the first part of January 1894.

The Baltimore "Sun" of March 26, 1894, mentions the fact of a Seal, about four feet in length, feeding for several days in the neighborhood of Thomas's Point lighthouse, near Annapolis, and at night sleeping on the stones about the foundation. It could easily have been shot, but the keeper of the lighthouse wished to take it alive, but was unable as it was too wild.

CYSTOPHORA CRISTATA (Erxl.)

Hooded Seal; Crested Seal.

This seal is rarely found south of the northern boundary of the United States, although stragglers have been taken at various times along the coast.

Prof. E. D. Cope has recorded its occurrence in Chesapeake Bay, where he mentions it as having been seen on two occasions.#

#New Topog. Atlas of Maryland, 1873, p. 16.

ELEPHAS AMERICANUS.[38]

Elephant.

Numerous remains of the Elephant have been discovered from time to time in different parts of the state.

The following extracts I have copied: "On the eastern shore of Maryland, in Queen Anne's County, an enormous grinder of the Asiatick elephant was likewise dug up, on the plantation of Mr. Carmichael, enveloped in stiff blue clay."#

"The great American Elephant at one time roamed over the fertile valley."*

#Geological Essays, Horace H. Hayden, p. 122.
*Scharf, History Western Maryland, Vol. 1, 1882, p. 32.

MASTODON GIGANTEUM.[38]

Mastodon.

The former existence of the Mastodon is proved by remains found at various times, and in various places.

Horace H. Hayden writes: "In digging a well in the star-fort of Fort M'Henry, a tooth of the Mastodon (or Mammoth) was found at the depth of near sixty feet below the surface."#

#Geological Essays, p. 121.

HYPOTHETICAL LIST.

SOREX DEKAYI (Bach.)[39]

De Kay's Shrew.

It is doubtful whether this northern species is found in the state, but Audubon says: "We have heard of its occurrence in Maryland."#

#Quadrupeds of North America, Vol. 3, 1856, p. 248.

SCAPANUS AMERICANUS (Harlan.)[40]

Brewer's Mole; Hairy-tailed Mole.

A northern species that may be found in the state, as it has been taken in the Allegany mountains farther south.

MUSTELA AMERICANA Turton.[41]

Marten; Pine Marten; American Sable

Possibly found in the mountains, but I have no record of its occurrence.

Audubon says it is found in Pennsylvania as far south as about latitude 40°.#

Dr. Elliott Coues says he has found no indication of its occurrence in Maryland.†

#Quadrupeds of Nor. America, Vol. 3, 1856, p. 179.

†Fur-bearing Animals, 1877, p. 94.

OCHETODON HUMILIS Coues.[42]

Little Harvest Mouse.

A southern species which may occur in Maryland. Audubon and Bachman say a specimen was sent to them from Virginia. They also say: "If we have not inadvertently blended two species, this animal can be traced as far to the northeast as the state of New York, several having been procured in traps on the farms in the vicinity of the city."#

#Quadrupeds of Nor. America, Vol. 2, 1856, p. 105.

HESPEROMYS AUREOLUS (Wag.)[43]

Red Mouse; Golden Mouse.

This is a southern species which has been recorded from Pennsylvania (doubtful).#

It may be found in this state.

#Monograph North American Rodentia, Coues & Allen, p. 92.

EVOTOMYS GAPPERI Vigors.[44]

Red-backed Mouse.

This boreal wood mouse possibly occurs in the high mountains of the state.

NEOTOMA FLORIDANA Say & Ord.[45]

Florida Rat; Wood Rat.

This is a southern species of which Audubon and Bachman mention having observed a few nests among the valleys of Virginia. Also, that they had heard it stated that one or two had been captured as far north as Maryland.#

#Quadrupeds of North America, Vol. 1, 1856, p. 36.

MUS RATTUS Linn.[46]

Black Rat.

In early days this species was brought to America in ships from the old world, but has since been nearly exterminated by the Brown Rat. It was,according to Jordan, introduced into this country about the year 1544.#

Audubon says this species is not so great a pest, or so destructive, as the Norway Rat.†

The Black Rat is said to still exist in New England, and in the Carolinas.

#Manuel of the Vertebrates, David S. Jordan, 1880, p. 31.

†Quadrupeds of Nor. America, Vol. 1, 1856, p. 191.

BISON BISON Linn.[47]

American Bison; Buffalo.

The Buffalo once roamed over nearly the whole of the United States, and its range is supposed to have extended into Maryland.

According to Wm. T. Hornaday, in his paper entitled "The Extermination of the American Bison", the last one in the neighborhood of Maryland must have been killed about the year 1795.

Quoting from the above: "The earliest discovery of the bison in Eastern North America, or indeed anywhere north of Coronado's route, was made somewhere near Washington, District of Columbia, in 1612, by an English navigator named Samuell Argoll. x x x

"Maryland,—There is no evidence that the bison ever inhabited Maryland, except what has already been adduced with reference to the District of Columbia. If either of the references quoted may be taken as conclusive proof, and I see no reason for disputing either, then the fact that the bison once roamed northward from Virginia into Maryland is fairly established. There is reason to expect that fossil remains of Bison americanus will yet be found both in Maryland and the District of Columbia, and I venture to predict that this will yet occur."#

#In Report of Natl. Museum 1887,p.p. 375, 378.

Annotations to Original Text

[1]*Nycticejus crepuscularis* LeConte = *Nycticeius humeralis humeralis* (Rafinesque), Evening Bat. Interestingly Paradiso (1969) had only a few records of this migratory species and all are from in and around Washington.

[2]*Atalapha noveboracensis* (Erxl.) = *Lasiurus boralis borealis* (Muller). While the sentence about the roost site preference of Red Bats is misleading and basically incorrect, the information in the second paragraph about the communal day roost found by Fisher is quite interesting. It is unfortunate that the date was not recorded in that this probably was during migration. To my knowledge such behavior has not been reported in this genus.

[3]*Atalapha cinerea* (Beauv.) = *Lasiurus cinereus cinereus* (Palisot de Beauvois).

[4]*Vesperugo fuscus* (Schreb.) = *Eptesicus fuscus fuscus* (Palisot de Beauvois), Big Brown Bat.

[5]*Vesperugo noctivagans* (LeConte) = *Lasionycteris noctivagans* (LeConte).

[6]Based on the comments made on the remaining three bats, it is obvious that Fisher was not personally familiar with any of them and probably confused several *Myotis*. For example, *M. subulatus* would be one of the least common species. Nevertheless it is interesting that by 1895 Fisher had accounted for all but two of the bats now known from Maryland (*M. sodalis, M. leibii*).

Vesperugo georgianus (Cuv.), Georgia Bat, = *Pipistrellus subflavus subflavus* (F. Cuvier)

Vespertilio subulatus Say = *Myotis keeni septentrionalis* (Trouessart) or *M. subulatus* (Say), but could have been any of several other species in that the taxonomy was in confusion at this time. See Allen (1893). *Vespertillio lucifugus* LeConte = *Myotis lucifugus lucifugus* (LeConte), Little Brown Myotis.

[7]*Blarina carolinensis* (Bach.). Although this species has recently been re-elevated, it is not known as far north as Maryland. Fisher refers to *Blarina brevicauda kirtlandi,* the only form of the Short-tailed Shrew known from Maryland.

[8]*Blarina cinerea* (Bach.) = *Cryptotis parva parva* (Say), Least Shrew. This is a common and widespread shrew in Maryland.

[9]*Sorex personatus* Geoff = *Sorex cinereus* Kerr. This is the most common and widely distributed *Sorex* in Maryland (two races now regarded as separate species) and the only species found in the area where Fisher lived. Four other *Sorex* species are now known from the state.

[10]These records are among the few where specific localities and dates are given. They were used by Lee (1987) in his discussion of the distribution of *Condylura* in the Southeast.

[11]Fisher's remarks on the two Panther skins presented to the Maryland Academy of Sciences substantiates Mansuetti's (1950) report of the same specimens.

[12]This record of the Lynx is perhaps the most interesting one in Fisher's booklet. Although the date the specimen was presented is not given, it was certainly prior to 1895. Therefore this represents the first record from the state. The one reported by Mansuetti (1950) from the Maryland Academy of Sciences was reported to have come in on 22 November 1917, and there is some question to its proper identity. The statement concerning identification by Baird removes any doubt concerning the pre-1895 specimen and strengthens the credibility of the 1917 Garrett Co. specimen. It may be on the basis of the pre-1895 Lynx that Cope (1873) stated that this was "not uncommon" in the mountains of Maryland. It is interesting that the record itself was unavailable for so many years.

[13]The name Bay Lynx was apparently widely applied to the Bobcats of the Southeast, *Lynx rufus rufus* (Schreber). Audubon and Bachman (1851) also used this name for Bobcats from the Southeast. Although not explained, the name seems to originate from this animal's use of bay forest and Carolina bays as areas of refuge during hunts (see Clark et al. 1985).

[14]The specific records of wolves in Cecil County (1724) and Garrett Co. (Negro Mountain, pre-1882) and of their existence in the eastern portion of the state (Montgomery County) through 1780 add considerably to the fragmented record of wolves in Maryland (Mansuetti 1950, Lee 1984). The account of the den and pups is also quite descriptive and the only such detailed information for the state.

[15]*Mephitis mephitica* (Shaw) = *Mephitis mephitis nigra* (Peale and Palisot de Beauvois), Striped Skunk.

[16]*Putorius erminea* (Linn.) = *Mustela erminea cicognannii* Bonaparte. Vazquez (1956) provides the first and only report of this species in Maryland (4 mi. NW of Bethesda, Montgomery County). Paradiso (1969) remarked that it may have escaped from captivity, and Lee (1985) noted that the measurements of the skull of this specimen were more like those of western populations. The closest known etablished population is in exteme northeastern Ohio and western Pennsylvania. Fisher's remarks on pre-1895 Ermines in Maryland are therefore quite interesting. The Prince Georges County record is geographically close to the one from Bethesda. Although the record is third hand, I should point out that Wm. Palmer was a well-known mammalogist and ornithologist of his time. Nevertheless, Irvin Hampe (Md. Nat. Hist. Society) told me of a white pelage Long-tailed Weasel (*Mustela frenata*) he collected in Baltimore County. The identification was confirmed by the late E. Ramond Hall. In that Fisher did not recognize that Long-tailed Weasels occured in Maryland, the other two records he reports are likely to be of this more common species. He implies that their pelage was not white.

[17]*Lutreola vison* (Schreb.) = *Mustela vison mink* Peale and Palisot de Beauvois. Fisher provides records from Baltimore and Queen Anne's counties, two areas from which Paradiso did not have any reported specimens.

[18]*Lutra hudsonica* (Lacep.) = *Lutra canadensis lataxina* F. Cuvier, River Otter. A surprisingly large number of early otter records are presented, indicating that the species was perhaps more common and widespread than it is today. A number of reports are from portions of the state where Paradiso (1969) did not have records.

[19]The statements indicating that bears were rare and confined to the mountains by 1895 is interesting and complements the information available to more recent authors. The 1780 report of the last bear from Sandy Springs provides a good indication of the period of disappearance from the Maryland Piedmont (although vagrants have ocurred since).

[20]*Didelphis virginiana* (Kerr.) = *Didelphis marsupialis virginiana* Kerr. It is perhaps informative to note that Fisher regarded the opossum as very common in 1845. The range of *Didelphis* has been expanding northward for a number of years. Cory (1912), for example, showed the species' northern limit as the New York-Pennsylvania border westward across southern Michigan, Wisconsin, and central Iowa. The opossum's abundance in Maryland the last part of the previous century indicates that it had already been present in the state for an extended period.

[21]*Sciurus hudsonicus* (Erxl.) = *Tamiasciurus hudsonicus loquax* (Bangs). Red Squirrels are no longer common and widespread in the Piedmont region of Maryland where Fisher made most of his observations.

[22]The black color phase that Fisher refers to in several places in the text is well known in *S. c. pennsylvanicus*, the race found throughout Maryland. However, today black individuals are rarely encountered as far south as Maryland; the closest population with black individuals I am aware of is in Philadelphia. I have not personally seen a black individual in Maryland, and it would appear that this genetic trait has shifted northward since the last century.

[23]*Sciurus cinereus* Linn. = *Sciurus niger vulpinus* Gmelin (in part). It is interesting that Fisher refers to the Fox Squirrel as the "Cat Squirrel" in that this is the name applied to the Gray Squirrel in the Deep South today (the Gray Squirrel makes a catlike sound, not heard in northern populations), whereas the light phase of the Fox Squirrel was in earlier times known as the cat squirrel in the northern portion of its range (see Audubon and Bachman 1856). Today this race is largely confined to the western mountains and western shore Coastal Plain of Maryland, although it is still found along portions of the Potomac River flood plain. Fisher's records of their former abundance in Howard County and their presence in northern Baltimore County confirm this squirrel was once in the Piedmont (see Paradiso 1969 and Mansuetti 1952).

[24]*Sciurus cinereus* Linn. = *Sciurus niger cinereus* Linnaeus (in part). Fisher provides the first description of the distinct silver phase of the Delmarva Peninsula Fox Squirrel, which was first named in 1920 as *Sciurus niger bryanti* by Bailey (1920). The Bryant's or Delmarva Fox Squirrel, as it was later named, is locally well known as one of the first animals recognized as Endangered by the U.S. Fish and Wildlife Service. Barkalow (1956) later renamed the race *cinereus*, the name Linnaeus applied to the light phase of the Fox Squirrel. (The name *neglectus* has also been used for the Delmarva population.) Nevertheless, Linnaeus did not indicate the geographic origin of *cinereus* and the type locality was later assigned by Barkalow (1956) as Cambridge, Dorchester County, Maryland. It is highly unlikely that the *cinereus* of Linnaeus was actually described from squirrels of the Delmarva area.

[25]*Sciuropterus volucella* (Pellas.) = *Glaucomys volans volans* (Linnaeus).

[26]*Arctomys monax* (Linn.) = *Marmota monax monax* (Linnaeus). Fisher's notation about Groundhogs being most plentiful north of Baltimore indirectly substantiates the general absence of Groundhogs on the southeastern Coastal Plain prior to this century (see Robinson and Lee 1980). The fact that Groundhogs climb trees has fascinated naturalists for some time, but Fisher's account is the earliest I have found. The first published account appears to be in 1922. Lee and Funderburg (1982) provide six literature citations in major journals on Groundhogs in trees just from the 1920's.

[27]Mansuetti (1950) and Bonwill and Owens (1939) provide detailed accounts of the extirpation and reintroduction of the Beaver in Maryland. The Beaver was apparently hunted out of the area where Fisher lived 100 years prior to the writing of his manuscript.

[28]*Sitomys americanus* (Kerr.) = *Peromyscus leucopus noveboracensis* (Fisher).

[29]*Arvicola riparius* Ord. = *Microtus pennsylvanicus pennsylvanicus* (Ord), Meadow Vole.

[30]*Arvicola pinetorum* (Leconte.) = *Pitymys pinetorum scalopsiodezs* (Aud and Bachman).

[31]*Fiber zibethicus* (Linn.) = *Ondatra zibethicus macrodon* (Merriam).

[32]*Mus decumanus* Pall. = *Rattus norvegicus* (Berkenhout).

[33]*Lepus sylvaticus* Bach. = *Sylvilagus floridanus mallurus* (Thomas), Eastern Cottontail.

[34]The 1860 record is the first for Maryland and had been overlooked by more recent authors (Mansuetti 1953, Paradiso 1969, Lee 1984). The Prince George County record is probably that of a domestic hare.

[35]*Erethizon dorsatus* (Linn.) = *Erethizm dorsatum* (Linnaeus). This is the first record for Maryland and it remained unknown to more recent authors. Fisher's writing preceded the complete destruction of the spruce forest of western Maryland, making records such as this one suggest that a faunal element no longer intact in western Maryland was extant at that time (see Lee 1976).

[36]*Cariacus virginianus* (Bodd.) = *Odocoileus virginianus borealis* Mike. Fisher's records help bridge the available information on the demise of the White-tailed Deer in Maryland. They were apparently hunted out, with the last one being shot in Allegany County about 1902 (see Mansuetti 1950).

[37]The Fort McHenry record had not been previously recorded. Although it seems unusual that a seal had pentrated this far north into the bay, DeKay (1842) reported on individual from Elkton caught in 1824.

[38]Although it seems strange that Fisher includes Mastodons and Mammoths in a list of Maryland's Mammals, this is not untypical of the time. Cory (1912), for example, includes mention of these and other fossil species in his *Mammals of Illinois and Wisconsin.*

[39]*Sorex dekayi* (Bach.) = *Sorex longirostris longirostris* Bachman, Southeastern Shrew. Fisher regarded this as a northern species perhaps based on the distribution of another race of this species in the upper Mississippi basin. The species appears to have been first listed for Maryland in 1950 (Gardner 1950). Pagels et al. (1982) discuss the distribution of this shrew in the central Atlantic Coast States.

[40]*Scapanus americanus* (Harlan.) = *Parascalops breweri* (Bachman). This species was first collected in Maryland in 1944 (University of Michigan) and is confined to the western counties.

[41]*Mustela americana* Turton. = *Martes americana* (Turton). Except for secondhand accounts there is still no good evidence that the Marten occurred in Maryland (see Mansuetti 1950).

[42]*Ochetodon humilis* Coues. = *Reithrodontomys humulis virginianus* A. H. Howell. First collected in Maryland in 1934 from Takoma Park, Prince Georges County. This is the only known collection from the state (Howell 1940, Feldhamer et al. 1984) and the northern known limit of its range.

[43]*Hesperomys aureolus* (Wag.) = *Ochrotomys nuttalli* (Harlan). This mouse has not been Mrecorded from Maryland.

[44]*Evotomys gapperi* Vigors. = *Clethrionomys gapperi gapperi* (Vigors). This is an abundant species in western Maryland. Apparently little, if any, small mammal trapping had been done in the higher elevation areas prior to this century.

[45]Now well documented from the state (Paradiso 1969, Thompson 1984).

[46]*Mus rattus* Linn. = *Rattus rattus* (Linnaeus) Populations of Black Rats have from time to time been established in Maryland. Whether these are from a persistent low-density population or are periodically reintroduced is unknown (Washington, D.C. [from shipping] 1912 and 1923, Paradiso 1969; Baltimore 1949, Davis and Fales 1949; lower Delmarva, Lee et al. 1972; and Garrett Co., Feldhammer and Gates 1980).

[47]Mansuetti (1950) and Lee (1984) provide summaries of Bison in Maryland.

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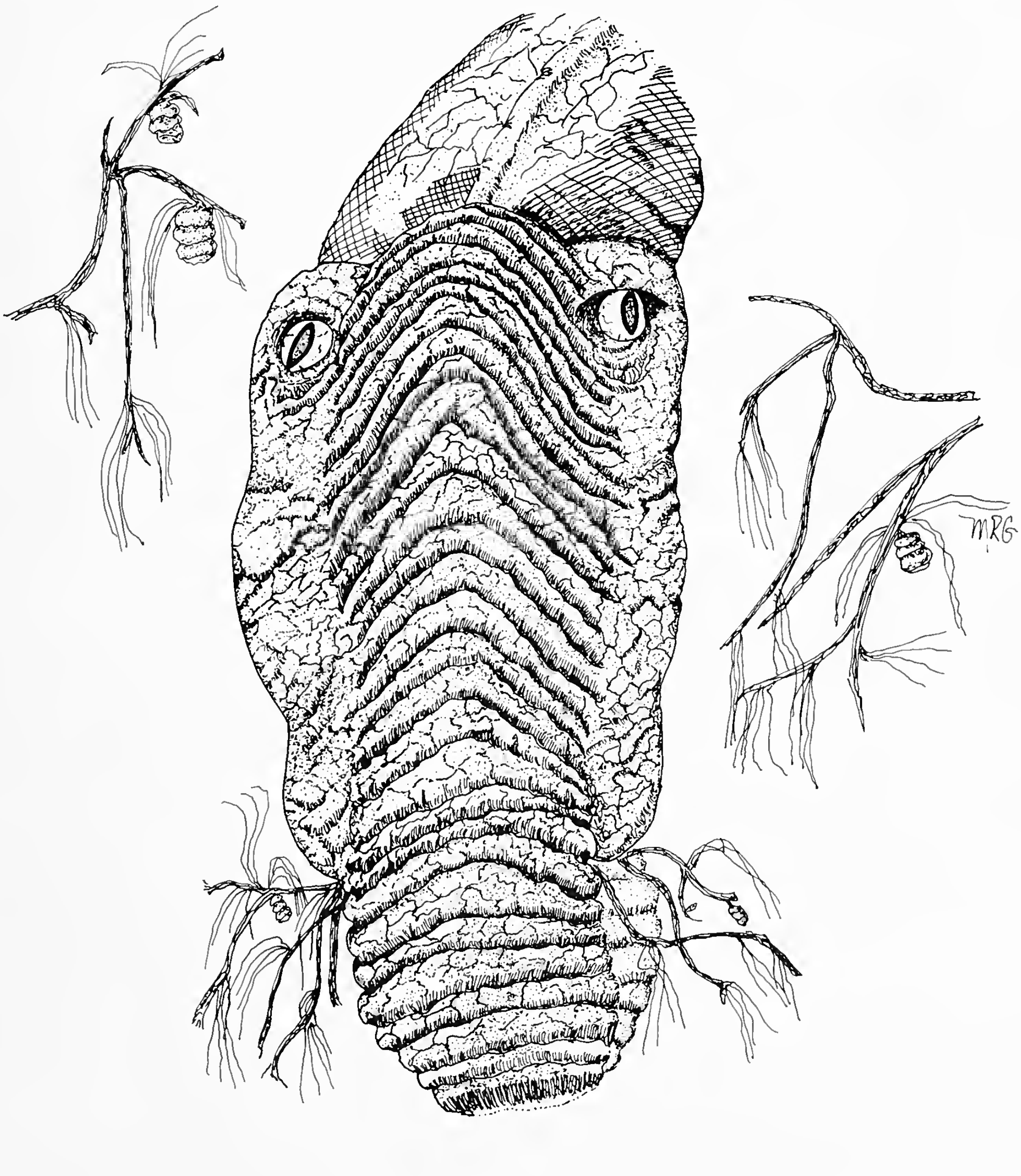

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Cover Illustration: *Pleurocoelus*, best known of the Maryland dinosaurs, was a sauropod reaching perhaps 17 meters in length. In this original illustration, Dr. Marc Gallup has restored it with a short trunk.

Damage to Violin Bow Hair by Dermestid Beetle Larvae

Stephen Bly Cunningham

During my career as a luthier I have re-haired hundreds of violin bows. The most common material used in this process is horse hair because of it's strength and ability to "pluck" the strings of a violin into motion. There are some mysteries about the hair of a violin bow, the solutions of which have not been well documented. For instance, why are so many old violins accompanied by bows that have no trace of hair? How is it that a fresh hank of bow-hair can deteriorate in as little as six months even though the performer rarely used the bow? What explains the accumulation of dust in a closed violin case? Considering the durability and longevity of any strand of hair, these questions prompted me to take a closer look at the environment in which violin bows are stored. I took this direction because for twelve years I have had some horse hair (too short for use in violin bow re-hairing) in an open box above my workbench. To this day the hair is strong and very durable, certainly undamaged.

In February of 1987, I questioned every violin repair customer about the age of his/her violin case and where it was stored. I noted the materials used in the construction of the cases and took dust samples from each. I put the debris from the cases in small plastic jars, gave each a specimen number corresponding to the case data, and brought them home for microscopic examination. Each sample of debris was placed on a slide and examined at 10X and 150X.

Information obtained from the first fourteen violin cases answered all of my questions. Most of the cases had been handed down from generation to generation, but some were of recent manufacture and one violin and case were only three years old. All had been stored for at least one year in varying locations throughout a house. Those that had been stored on the second floor or attic had more severe damage to the hair of the bow than those stored on lower floors or in a basement. When damaged horse hair was found, the microscope revealed symmetrical bite patterns on every piece examined. The "dust" from all fourteen violin cases contained the larval husks and fecal pellets of at least one species of dermestid beetle (commonly called carpet beetles). Nine of the cases contained more than one species. I found a greater number of husks in the cases that had been stored the longest. Three cases provided me with live larval specimens for further study. Only one case contained an example of another creature, a small spider.

Identification of my live specimens showed that I had both *Attagenus piceus* and *Anthrenus verbasci*. I kept these specimens in separate petri dishes and fed them a diet of horse hair, felt violin case lining, and chips of the glue used in the construction of some violin cases. After several days all of the food had been tried and the horse hair

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in each dish showed the same kind of bite marks as hair from the damaged bows. Careful examination of the mandibles of my specimens showed how these larvae could "scoop" out a symmetrical pattern in such a hard substance as horse hair. The bottom of each dish was covered with fecal pellets similar to the dust in each of the violin cases. Identification was confirmed as each larva transformed into an adult beetle.

For the next several weeks I conducted a survey of the cases of every type of instrument that came to me for repair. During that time I studied the debris of twenty-one violin cases, seventeen guitar cases, ten banjo cases, three mandolin cases, and three autoharp cases. Fourty-six of the fifty-four cases yielded evidence of dermestid larvae (twenty-one cases had more than one species), and only three cases turned up other types of insects. Of the fourty-six cases that yielded positive evidence of dermestids, twenty-four contained *Attagenus piceus* and thirty-five contained *Anthrenus verbasci*. Even though the occurrence of other dermestids was rare, I found seven species in all.

The appetite of dermestid beetles for horse hair may be incidental to their attraction to the environment of the instrument cases, for they favor dark, dry surroundings during their development. Furthermore, hair is only one of the materials found in instrument cases which could provide dermestid larvae with nourishment. I have also observed larvae feeding on glue, leather, felt, fingernails, dandruff, human hair, cat hair, other insects, and even shed larval husks. However, the horse hair of a violin bow will succumb to damage caused by these larvae much faster that any other object in an instrument case.

5502 Belair Road, Baltimore, Maryland, 21206.

A New Look at the Old Dinosaurs of Maryland

Marc R. Gallup

Introduction

This paper could probably have been written 90 years ago, although perhaps without much of the data on paleoflora and paleogeography and the speculations regarding the ecology and behavior of some of the dinosaur species. It is this new information that motivates this paper: improvements in our understanding of extinct species as living organisms increases the public interest in them.

Importance of Maryland Fossils to the History of Fossil Collecting

A wealth of fossils are known worldwide to have come from the rich fossiliferous rocks of Maryland. Volumes by the Maryland Geological Society over the last 90 years show a tremendous variety and quantity of marine invertebrates and trace fossils. So, it is without surprise that collecting began almost simultaneously with the establishment of the first settlements in the state. In 1821 a published note described a beautiful piece of amber, followed by a considerable number of papers on marine shells of the state by various collectors such as G.Troost. These reports of impressive finds spurred the geological surveys of Maryland in the 1820s and 1830s as researchers sought to understand the geology of the eastern portion of the country. These broad surveys resulted in descriptions of Paleozoic and Mesozoic fossils, many from Maryland, beginning in the 1850s.

In contrast to the wealth of invertebrate fossils, dinosaur finds are the fortuitous result of increased mining operations in the state as well as road and well construction. Teeth were the first to be described (Johnston 1859). These and the rest of the vertebrate fossils come from the Potomac Group and are restricted to a narrow belt through Maryland (Figure 1). Dinosaur remains have come from Prince Georges, Anne Arundel (unverified), and Baltimore (unverified) counties and from Washington, D.C. Prospecting has not been extensive since paleontologists are aware that the relevant strata lie below the surface, and collecting has been restricted to exposures at road or railroad construction sites. For this reason, the Maryland dinosaur collection is extremely small but an important relic of the early Cretaceous, a time of transition between a dinosaur flowering in the latest Jurassic and the final extinction at the close of the Cretaceous.

One very interesting and important nondinosaurian portion of the lower Cretaceous component of Maryland fossils is the paleoflora, from which comes evidence of the first angiosperms or flowering plants (Hickey and Doyle 1977). Leaf fossils of both monocots and dicots are represented but come from the Patapsco Formation, which is further up in the Potomac group than the dinosaurs. While the fossils do not give clues about the origin of this now dominant group of plants, they do establish their first appearance and raise questions as to their primitive morphology, rapid subsequent diversity, and geographical spread.

Bakker (1986) suggests that these botanical newcomers may be linked with the dinosaurs in a new way. In contrast to the old but not necessarily universal view that dinosaur decline was directly tied to the dramatic rise in the dominance of the angiosperms due to the presence of leaf toxins or resilient organs, he argues instead that the dinosaur herbivores provided a very strong

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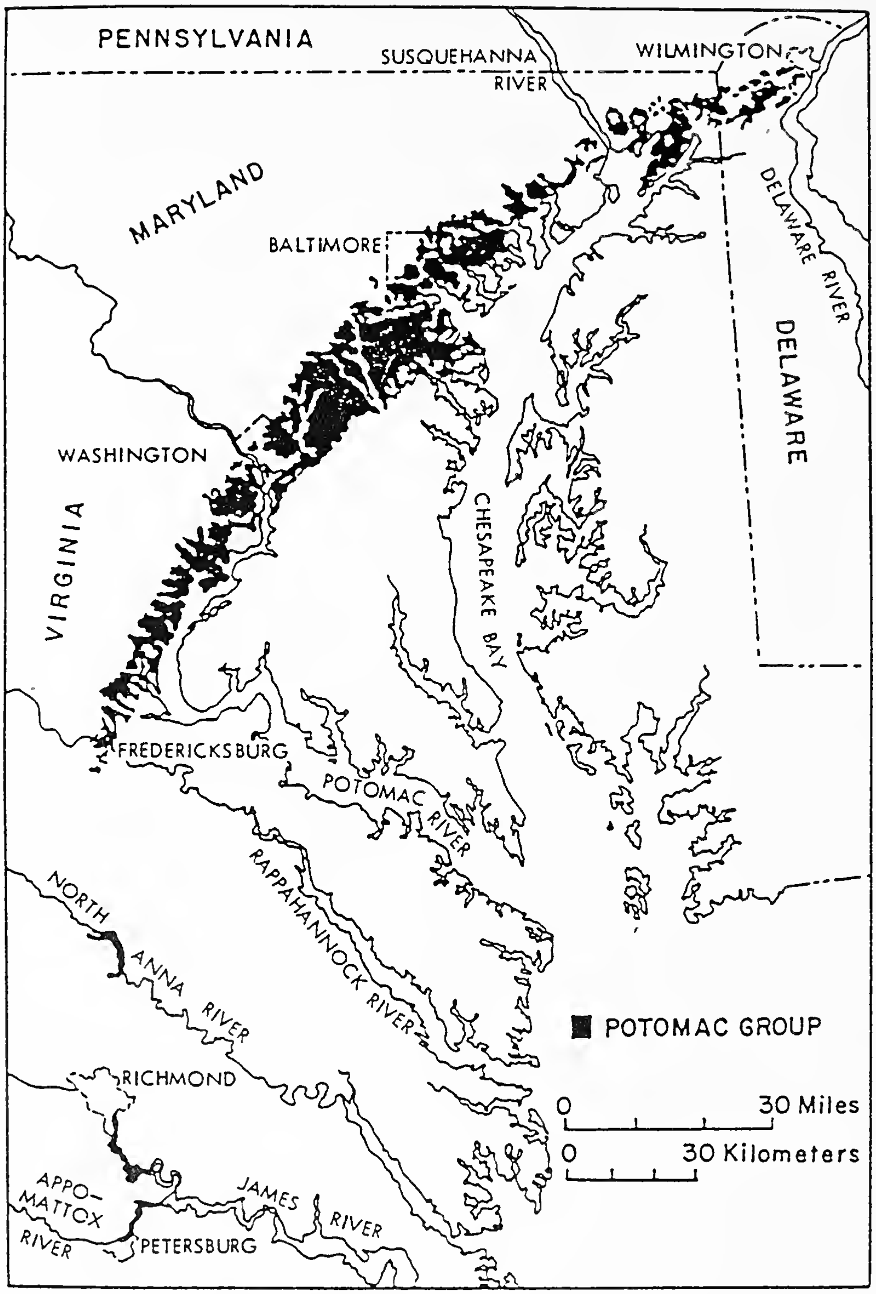

Figure 1. Outcrop map of the Potomac Group in Virginia, Maryland, and Delaware (from Hickey, 1984).

selective pressure on even the earliest members of angiosperms partly by eliminating competition. Because of its highly speculative nature, this hypothesis continues to cause quite a stir among skeptical paleobotanists.

In addition, a handful of dinosaur material has been collected from nearshore marine deposits of the Upper Cretaceous Severn Fromation of Prince Georges County. Most likely, this poorly preserved scrap, described as "mutilated" by Baird (1986), was floated into its burial place by an ancient river. Dated as middle Maestrichtian, the material was deposited about 71 million years ago (Baird 1986).

Paleogeography

The early Cretaceous climate of Maryland and other areas of the North American continent was equally warm and humid or warm and temperate. The plate tectonic cycle had created the still small Atlantic Ocean (more a sea) some millions of years earlier, but the eastern boundary of the continent, including Maryland, was still rather close to the land masses of both Africa and Laurasia. The vast, shallow seaways of Jurassic times that covered much of the western interior had regressed to the north leaving muds and shallows. Maryland, which may have been close to 30^{o} N latitude but tilted to the south during the early Cretaceous, was, during this period, swampy or marshy and, like North America in general, tectonically active.

The state consisted of well-watered, but apparently not well-drained, broad lowland plains nearshore, as evidenced by lignites or altered plant remains. It may have been the sort of environment that dinosaurs, at least the larger ones, wished to avoid. On the other hand, it does seem to have been an area at least locally rich with plants, including conifers, cycads, and odd relatives of these, the cycadeoids. These latter trees had extremely broad, short trunks consisting, we believe, of rather spongy tissues that could have been highly prized as food.

The dinosaurs come exclusively from the middle formation of the Potomac Group—the Arundel clay—a predominantly grey, brown, or red clay with iron-oxide concretions and iron carbonate and limonite nodules as well as abundant wood and lignite representing swamp or backwater deposits (Hickey 1984). Sediments of the Potomac Group seem to be mainly Albian in age, deposited approximately 108 million years ago. According to Hickey, these sediments appear to have been deposited on fluvial floodplains along the wetter proximal portions of large deltas. Fossil crocodilian teeth of the *Goniopholis* type and chelonian remains confirm a freshwater environment. The Arundel is often difficult to separate from the Patapsco Formation, above, or the Patuxent Formation, below.

The Dinosaur Fauna

Five components comprise the Maryland Arundel dinosaur fauna: (1) the small carnivores or omnivores, specifically the coelurids and the ornithomimids; (2) at least one large meat-eater, *Dryptosaurus*; (3) the sauropod *Pleurocoelus*, or *Astrodon*, assumed to have been herbivorous; (4) the large ornithopod (herbivorous) *Tenontosaurus*; and (5) *Priconodon*, a primitive armored dinosaur or ankylosaur, also probably herbivorous. The first three of these belong to the subclass Saurischia, while the last two belong to the Ornithischia. It is a depauperate fauna, as preserved. What little fossil material exists is in the form of isolated bones, fragments, and teeth. Because of its size and form, its value for correlation and faunal comparisons has diminished over the years as more data have been acquired from Lower Cretaceous deposits in Wyoming, Montana (Cloverly), Utah (Cedar Mountain), the Gulf Coastal Plain (Paluxy, Trinity), and others.

The Upper Cretaceous Severn Formation has not fared any better—a portion of a femur (Baird 1986) and a tooth (David Bohaska, personal communication, 1988) belonging to a hadrosaurian, or "duck-billed," dinosaur are the sole record we possess.

The smallest dinosaurs, the coelurids (Figure 2), represent a guild of carnivores, which I suspect may have been rather numerous, feeding on a variety of items—arthropods, lizards, birds, eggs, mammals—anything not able to eat them faster! Their skeletons would have been fragile and turkey-sized, with long jaws and numerous narrow, serrated teeth (which have been found) for quickly and efficiently dispatching prey. In addition, skeletons of these forms suggest speed and agility, perhaps allowing them to ambush their victims with a last-minute rapid rush from underbrush or an overturned log. I think of them as the jackals or foxes of the dinosaur fauna: fleet of foot, perhaps not adverse to feeding on carrion, and perhaps traveling in packs

that could have facilitated taking larger prey as food. Suggestions of group behavior have become more numerous in the last several years based on inferences from multiple trackways of other dinosaurs. Few deny that such behaviors were possible, but evidence is not abundant.

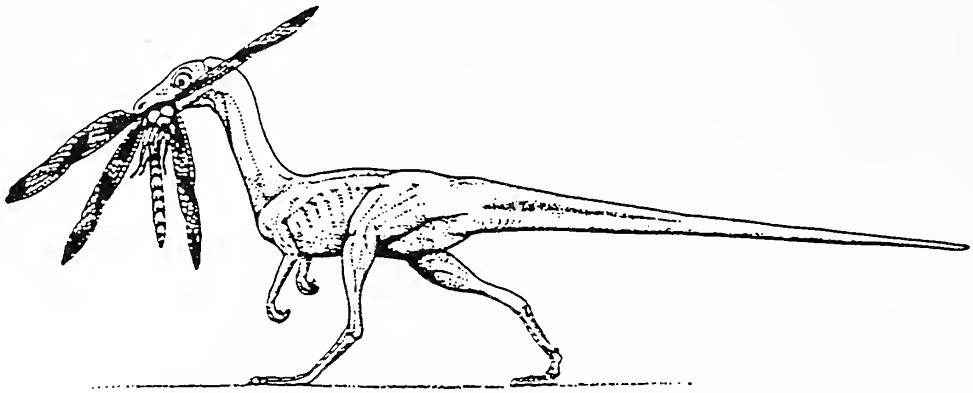

Figure 2. An agile, quick coelurid (from Am. Sci. 1988).

The ornithomimid, or "ostrich dinosaur," may always be an enigma. Not typical of saurischian dinosaurs, it might have been as ostrich-like in its habits as its morphology suggests (Figure 3). Most probably a fleet runner as indicated by the length and proportions of its legs, it apparently ran *away* from most other dinosaurs rather than toward them. Its toothless jaws formed a short, beak-like snout and suggest it was an herbivore or insectivore, but the jury is still out. Ornithomimids appear to have had good vision and some degree of manual dexterity, if we can infer for early Cretaceous forms from the better preserved late Cretaceous forms. Perhaps forest dwellers, these animals would not surprise us if their remains turned up in an ancient swamp environment. A few finger bones are all we have of this creature.

The largest carnivore, or theropod, has unfortunately left a very incomplete record. Presumably allosaur-sized (about 25 feet long) and bipedal, it has been referred to *Dryptosaurus* and possessed large, saber-like teeth. Anything else about it will have to wait for more fossil material. It is conceivable that it may not have been as out-of-place in the swamp as has been previously thought, since at least one theropod track of another species has been interpreted as being formed under water.

A number of formal species designations exist for the sauropod remains in the Maryland fauna, given to teeth, various limb bones, vertebrae, and ribs of several different sizes. Conceivably, only one valid species may be represented, but at present we cannot tell. In the rest of this discussion, I refer to all Maryland sauropod material as *Pleurocoelus*; other paleontologists may prefer the name *Astrodon*. It is with this species that we encounter bones of real interest; in addition to a number of postcranial bones (including several rather large ones), we possess the wonderful specimen of a partial skull or, more accurately, a partial jaw and palate belonging to a very young individual. Equally small toe and ankle bones are also in the collection, although we cannot say with certainty that they are associated. These elements are so small that one is tempted to consider the animal a yearling or, at most, a two-year calf. Even though the skeleton is very incomplete, the fact that the delicate bones of the foot are so well preserved suggests that this small animal died very close to the point of burial. This inference stems from observations that the digits of the hands and feet of carcasses floating in cattle tanks and other bodies of water

fall off first, along with heads (when you study paleontology, you study processes that follow death), and that there is no evidence of stream transport on the bones.

Figure 3. A fleet ornithomimid (from Bakker 1986).

Several types of sauropod teeth are represented in the collection. In some, the enamel or hard outer layer of the tooth has a distinctive texture that calls to mind a star pattern, hence the name "astrodon." Such peg-like teeth are often black with brown stains and are easily recognizable. The small teeth belonging to the partial jaws are not peg-like but instead are almost spears, showing more than a slight amount of wear. Such teeth could not masticate plant material; they might have handled flesh or some other fleshy material. To me this juvenile sauropod is the most interesting specimen of the collection.

Adult "pleurocoeli" presumably reached a good size, perhaps 17 meters in length. Lessening the weight contributed by the bony skeleton, particularly along the central vertebral column, vertebrae are hollowed out to form large cavities that serve to decrease the load but not the strength needed to support the body. The name *Pleurocoelus* is derived from "pleurocoel," the name given to these vast cavities.

Our picture of how the Maryland sauropod might have looked (Figure 4) is based mainly on the more plentiful remains of a Texas species. A brachiosaur, it may have had shoulders slightly taller than hips, with rather long legs, a relatively short but weighty tail to counterbalance the neck and trunk, and a long neck, even for a sauropod. Feet had well-formed toes with large

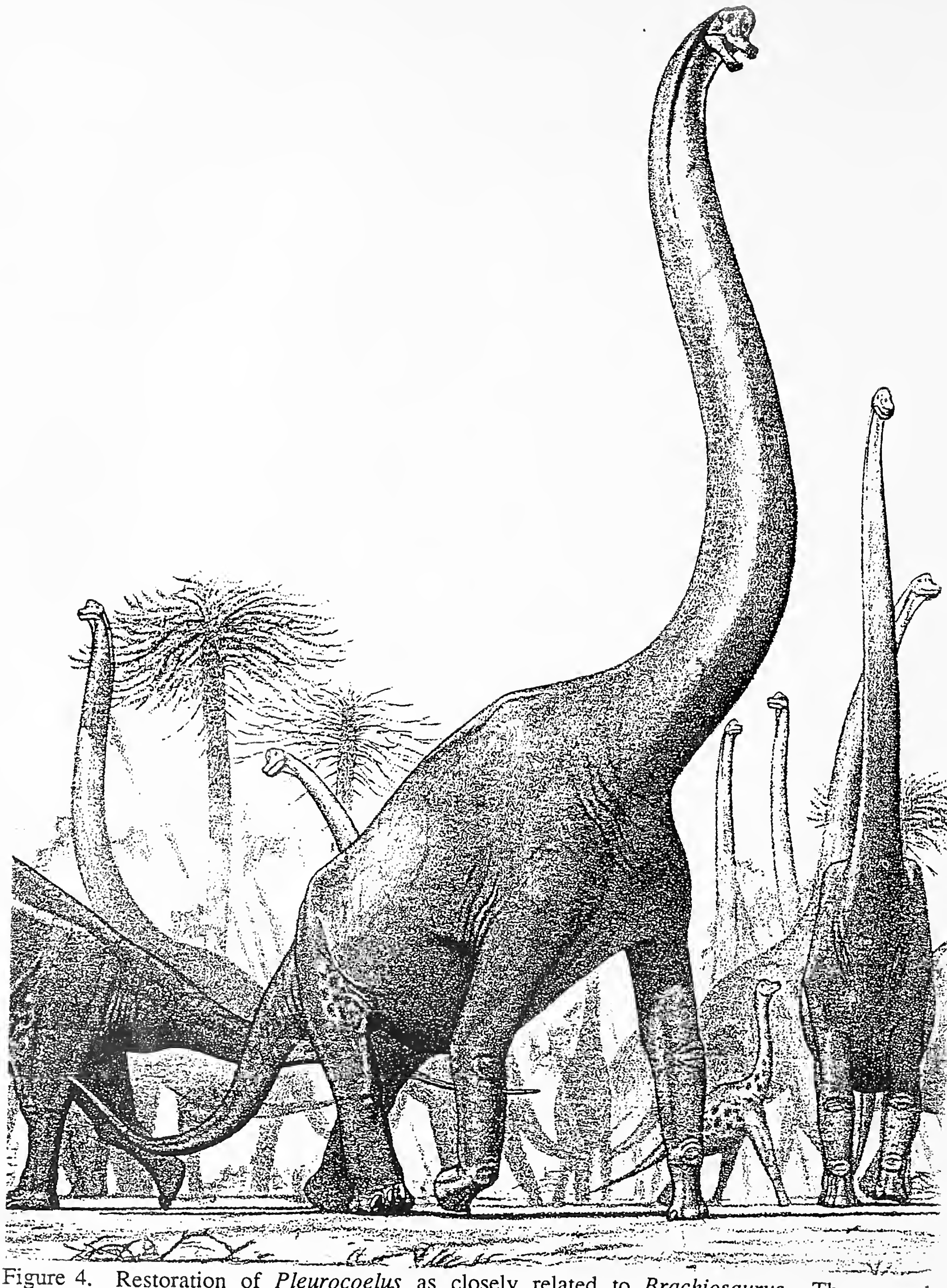

Figure 4. Restoration of *Pleurocoelus* as closely related to *Brachiosaurus*. The several "species" of the Maryland sauropod genus may indeed have been the juveniles of only one species (from Paul 1987).

claws in the hind feet that may have had a variety of uses, including, possibly, a digging function, helping to scratch out a nest in soft earth or to disengage bark from a tree trunk. Although these beasts are thought to have a rather varied repertoire of behavior, as inferred from trackways of several other species, paleontologists feel that they had the most limited cerebral faculties of all.

In spite of their huge size, sauropod remains do not provide as many clues to their biology as they do issues for healthy speculation. For instance, how could such a relatively small head process enough food to fuel such a huge body? Most of their waking hours must have been spent obtaining and processing vegetation. Because of the form of the adult teeth and their confinement to the jaw margins and the absence of dental batteries to masticate food, food probably was swallowed relatively whole and quickly. Then, most likely final processing occurred in some sort of a gastric mill and lengthy intestine.

A long neck would have permitted it to reach and procure the high foliage, tender twigs, and fruiting structures of marsh conifers and other gymnosperms, with an occasional angiosperm or two. Obviously, if we knew the cervical length of *Pleurocoelus*, we would know its maximum browsing height. Paleontologists hypothesize that the different relative lengths of the necks of various sauropod taxa represent different browsing heights in the forest canopy (see Bakker 1986). The Cretaceous seems to have been a time of sauropod decrease (Bakker 1986), in which, perhaps, browsers were replaced by grazers (that is, ornithischians). I picture *Pleurocoelus*, and perhaps all sauropods, as occupying an ecological niche somewhere between that of the giraffe and of the African elephant. With some evidence that at least several species of sauropods traveled in herds (Ostrom 1972), I suspect that one of the ecological consequences of such groups would have been to "devastate" areas of forest, creating open spaces that provided "islands" for the social activities of various other animals as these areas do today. Like African elephants, the sauropods' treading across and enlarging watering holes and stripping and pushing down trees would have been a necessary ingredient for the continuation of the diversity of local animal and plant life. Perhaps one of the consequences of that large sauropod foot was the successful foothold gained by the flowering plants. Creating open spaces could have allowed pioneering species to invade adjacent areas and then to speciate. A number of scientists have suggested that at least several species of sauropods were migratory animals, and if so the herds may have been instrumental in altering the landscape over a wide geographical area, for example, between Texas and Maryland.

In the cover illustration, I have restored a trunk on the face of *Pleurocoelus*. Although it is speculative, there are arguments to support the presence of this structure, although few other restorations show it. If we accept that *Pleurocoelus* is a brachiosaurid and, consequently, possessed the backward placement of the narial openings and their elevation on top of the bony hump of nasal bones as in *Brachiosaurus*, a trunk provides a rationale for this and a number of other oddities of sauropod natural history.

Such a morphological structure could help explain slow apparent wear on the feeble-looking teeth, which by all other accounts should have been quickly worn to the gums by the constant processing of the tough and abrasive plant material that probably constituted the *Pleurocoelus* diet. A trunk could have pulled vegetation to the mouth, perhaps even plucking it from the branch, thus saving much wear on the teeth. Such conservation of dental wear is observable today in some browsers, such as the plucking activity performed by the lips of deer. A trunk also would have facilitated drinking for such a long-necked form and could have been crucial to thermoregulation by spraying water onto the back or flanks for evaporative cooling, much as modern elephants do. Bakker (1986) feels that the large narial openings provided a large surface for evaporative cooling to keep the brain relatively cool. A trunk would have provided this and a great deal more.

A variety of fleet, herbivorous dinosaurs, termed ornithopods, are known from other Lower Cretaceous deposits outside of Maryland, and the large hypsilophodontid *Tenontosaurus* is one now known from the Arundel. A portion of a tooth is all we have for the Maryland form (Galton and Jensen 1979). The restoration shown in Figure 5 may suggest a more slow-moving hypsilophodontid than the smaller forms from elsewhere, and their rather large low-crowned molar-like teeth may indicate a trend towards grazing. A large mobile snout (Ostrom 1970) with a large, cropping beak coupled with a mandible capable of rather wide, lateral, shearing motions (Forster 1984) suggest an analogy with a large artiodactyl. I imagine them as the "wildebeests" of the dinosaur fauna, possibly traveling in herds.

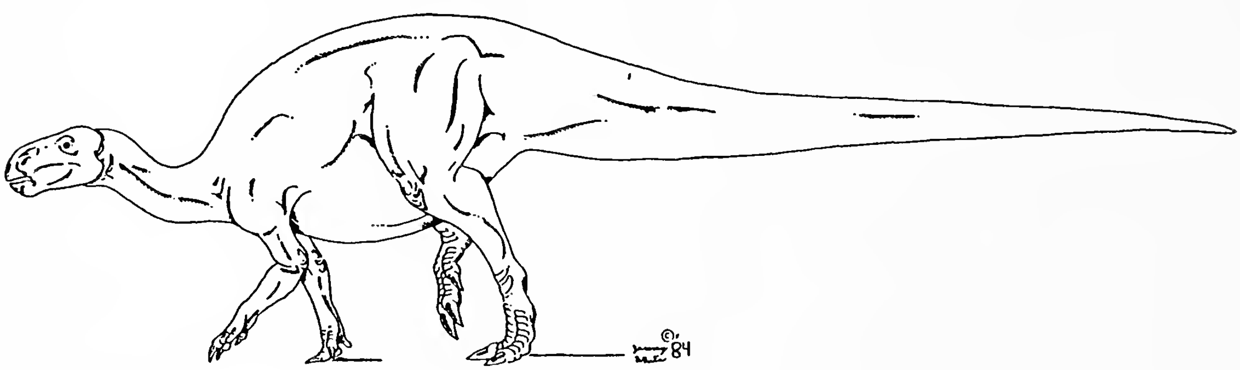

Figure 5. Restoration of *Tenontosaurus*, a hypsilophodontid ornithopod. Note the straight tail for counterbalance. It probably was quadrupedal for most speeds and could, perhaps, become bipedal at its highest attainable speeds. From Forster 1984, p. 153.

Finally, Maryland deposits have yielded only a few stream-abraded teeth of a nodosaurid, referred to *Priconodon*. This species may have been a more upland form whose remains were carried some distance downstream. Although any evidence of a nodosaur in the early Cretaceous is gratifying, the relative shortage of ornithischian remains in the Arundel is extremely disappointing. Most certainly the goal of any future collecting is the reversal of this scarcity.

The absence of many taxa in the Maryland deposits speaks for a real insufficiency of collecting in the state. Much more material is expected. Obviously, more ornithischians and at least one other group of small theropods—the deinonychids—can be presumed to have been present in the fauna. These forms possessed the large, fearsome claw on the second toe that probably allowed them to kill prey quickly by shredding and disemboweling. I must note that in the National Museum collection I did come across a tooth that fit the size and shape of a deinonychid tooth, but its dental serrations were worn too smoothly to allow positive identification. Mammals, pterosaurs, and even birds would be most welcome, but discovery of the former may have to be delayed until sediments can be screened on a large scale. With additional collecting, we may find that *Dryptosaurus* is synonymous with the tyrannosaur *Acrocanthosaurus* from the Gulf Coastal Plain. Active prospecting at roadcuts and railroad cuts should continue, but active searching of likely spots using digging machinery must also be done, since dinosaur-bearing deposits lie under our feet.

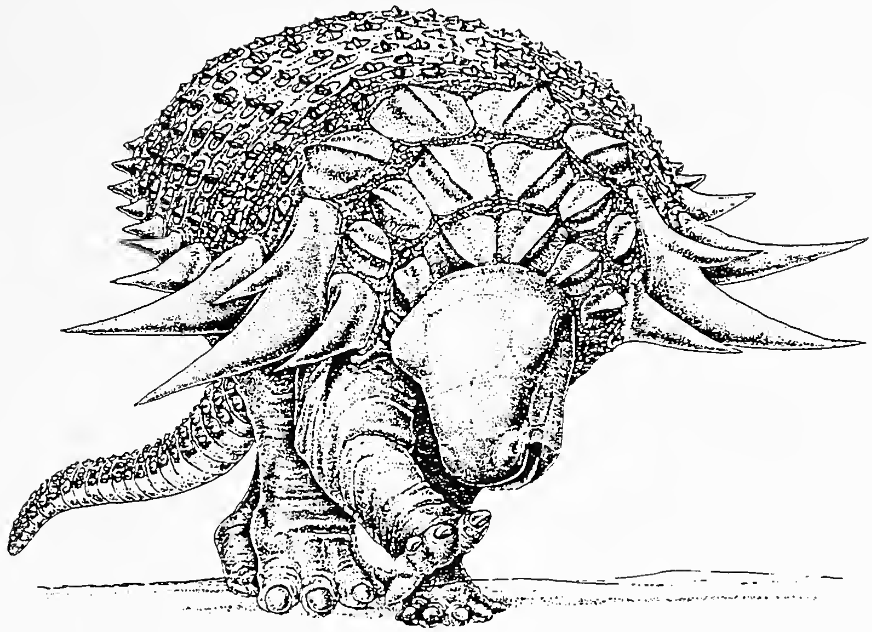

Figure 6. A conception of *Priconodon*. Not nearly enough of this dinosaur exists to restore it with confidence (from Bakker 1986, representing *Edmontia*).

Fossil Collecting

The reader who finds fossils of any kind, especially those of dinosaurs, is most graciously urged to notify a museum and not to attempt to remove them. It might be prudent not to tip other people to dinosaur fossil finds since such reports seem to arouse the "collecting urge" in many individuals. Because great professional care is required to remove fossils from their burial sites, careless or amateur attempts could result in their destruction. Remember, the aim is to secure the natural resources of Maryland for the enjoyment of all its citizens.

Conclusion

The collections that constitute our knowledge of Maryland dinosaurs are far from being complete, although the few specimens collected over the past 130 years are familiar to dinosaur paleontologists. New specimens, resulting from removal of subterranean strata during tunneling or other construction, are eagerly awaited, and any new finds could greatly add to our still fragmentary knowledge of this exciting era in Maryland geological history.

The listed references that follow pertain mainly to the Maryland dinosaur fossils, but a few general references are also provided for further reading.

Acknowledgments

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Flowering Sequence of Some Goldenrods in North-central Maryland

Haven Kolb

The goldenrods (*Solidago*) are predominantly North American plants with one (or a few, depending upon taxonomic interpretation) species in Eurasia and two in South America. They are particularly conspicuous in northeastern United States where more than sixty species occur. One of these (*Solidago verna*, an endemic of the Carolinas and on the list of endangered species) flowers in spring. All others are essentially post-solstice blooming, though a few species in south Florida may be found in flower at almost any time of the year.

Even the small area that is Maryland contains about 30 species of *Solidago*. All of these flower in summer and, sporadically, until severe frost. However, it soon becomes apparent to anyone who has learned to distinguish at least some of the species that all do not flower at once. The temporal sequence of flowering is of some use in learning to know them and it is principally with this in view that the following observations are presented.

The season at which any plant flowers is dependant both upon genetic factors and upon a wide range of environmental ones, among which are geographical location, elevation, soil, light, and weather. To reduce the variance of environmental factors I first restricted my observations to the Lineboro Quadrangle (U.S. Geological Survey) in Baltimore and Carroll Counties. Second, I made observations over a period of many years. Third, I restrict this report to species growing naturally in the study area, eliminating garden plants transported from elsewhere. The data are derived from a more extensive study of the seasonal development in *Solidago* plants. Observations were usually made weekly. The dates listed in the table are those on which one or more heads on one or more plants had expanded ligules (rays). This condition is easy to observe and, therefore, has some advantage over the determination of the presence of pollen, which is biologically more significant. The pollen-bearing disk florets usually open several days after the ligules have expanded.

The names used in the table are those given in Brown and Brown (1984), and there the authorities for the Latin names can be found. A somewhat different set of English names can be found in Peterson and McKenny (1968). In both these references, and in others, *S. gigantea* is given the name "late goldenrod", though the table clearly shows this to be a misnomer. Some other English names are also poor, but less so than this one.

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Species	Years of Record	Earliest Date	Average
Solidago juncea early goldenrod	11	1977-07-12	07-18
Solidago gigantea late goldenrod	10	1977-07-14	07-21
Solidago ulmifolia elm-leaf goldenrod	7	1987-07-15	07-29
Solidago odora sweet goldenrod	6	1982-07-16	07-27
Solidago graminifolia grass-leaved goldenrod	13	1977-07-22	08-08
Solidago caesia blue-stemmed goldenrod	7	1983-07-27	08-04
Solidago rugosa wrinkle-leaf goldenrod	13	1983-08-10	08-27
Solidago bicolor silver-rod	11	1985-08-08	08-21
Solidago patula rough goldenrod	9	1980-08-11	08-16
Solidago nemoralis dwarf goldenrod	10	1977-08-12	08-16
Solidago altissima tall goldenrod	8	1987-09-02	09-04

Note that four of the eleven earliest dates were in 1977 and that 1983 and 1987 both had two earliest dates whereas many years had none. This may be taken as evidence that the data provide a rough indication of meteorological variations from year to year.

It is not possible to state clearly the end of the flowering season for a given species. For example, though the great majority of individual plants of *S. juncea* has completed flowering before the end of August, a very few individuals may be found flowering in September. In this case a close examination will almost always show that such individuals have been injured in some way. Mowing of fields and roadsides is often the occasion of such injury and a consequent abnormally late flowering. But in north-central Maryland the arrival of heavy frosts in November effectively terminates goldenrod flowering for the year.

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The Egg Collectors

Brooke Meanley

When I began studying birds in Baltimore County in the late 1920's, as far as I could ascertain, the most active ornithologists in the state of Maryland were egg collectors. Perhaps they should be referred to as Oologists, those who collect and study birds' eggs. However, in addition to building an egg collection, those men had a general interest in ornithology, especially bird identification, avian distribution and ecology.

When egg collecting was in vogue in much of North America, the collectors published in such journals as the *Oologist* and the *Ornithologist and Oologist*. Those journals had many interesting papers concerning the adventures associated with some hard to find bird nest.

The leading egg collectors in Maryland in the early 1900's were Frank C. Kirkwood of the Jacksonville-Sweetair section of Baltimore County, and the author of the first book on the birds of Maryland (1895), John Sommer, a Baltimore business man, E. J. Court of Washington, D.C., who did much of his egg collecting in Maryland, and Dick Harlow, head football coach at Western Maryland College. Harlow did much of his early collecting out of state, and later became head football coach at Harvard, where he was also curator of Oology at the college's Museum of Comparative Zoology. An egg collector by the name of A. Wolle, that I did not know, built up a large egg collection that was on exhibit at the old Maryland Academy of Sciences building on North Charles Street.

For the adventurous egg collector, each episode was like a treasure hunt. The variety of colors, patterns, designs, and shapes of birds' eggs taken together were like a box of jewels, especially the eggs of some of the smaller songbirds like the Chipping Sparrow (*Spizella passerina*), Wood Pewee (*Contopus virens*), and some of the warblers.

The egg collectors would travel from one end of the state to the other in search of the nests and eggs of some uncommon bird, just as today's birdwatchers or birders will travel endless miles to see some rare bird visitor from Europe. Most of the collectors would take only complete clutches, and after a long arduous trip by train, boat or "Model T" Ford to Assateague Island or Garrett County, they would make the most of their trip by collecting several sets of eggs of various species, which they would use in trading with other collectors in or out of the state.

Since the majority of species of birds nest in trees, the basic equipment of the egg collectors was a set of lineman's climbers like the telephone people use, and a lot of rope. Such equipment was especially important in climbing to the higher nests of hawks

and eagles. It would often take 20 or 30 minutes to climb to a nest 75 or 100 feet in height, but using a special technique, only two or three minutes to descend. To get ready for the descent, the climber would lower the rope to a companion on the ground who would play it out for a couple of hundred feet. Then the climber would tie the rope around his waist and drop over the side of the limb; and as the man on the ground walked toward the trunk or base of the tree the climber would steadily be lowered to the ground. Some egg collecting missions were quite dangerous. Dick Harlow told me that every time he went over a steep cliff after a Peregrine Falcon's (*Falco peregrinus*) or Raven's (*Corvus corax*) eggs he felt like he was living on borrowed time.

Figure 1. Charlie Rittler climbing to Barn Owl's (*Tyto alba*) nest at Lake Roland, Baltimore County, May 1936. The Nest Contained two young.

Among other equipment used by some egg collectors was a can of fresh water to test all eggs found. If the eggs floated, incubation was to far advanced to blow out the contents of the eggs through a small hole in the side, and thus the eggs were not collected.

Figure 2. Nest and eggs of Spotted Sandpiper (*Actitis macularia*) at College Park, Prince Georges County, Maryland in May.

By the 1930's, egg collecting began to die out in Maryland and elsewhere. The last time I accompanied several egg collectors was in the mid-1930's. Two Baltimore oologists of a younger generation, Charles Rittler and Church Yearley asked me to go with them to take pictures of a Great Blue Heron (*Ardea herodias*) nesting colony in the Patuxent River bottomlands near Bowie. Church, a tall fellow (6'4"), had a brand new Leica camera, and while crossing a log over a branch of the Patuxent, fell in and had to have the camera completely overhauled. We did not locate the heron colony, but found a Barred Owl (*Strix varia*) nest with three young. The photograph of the owlets was one of the best I ever made. Also, on that trip I saw my first Pileated Woodpecker (*Dryocopus pileatus*).

It is unlikely that egg collectors had an adverse impact on Maryland bird populations. It has been suggested to me that collecting eggs of some of the larger

raptors, the Bald Eagle (*Haliaeetus leucocephalus*) and Osprey (*Pandion haliateus*) may have affected those populations, but the eggs of those species were taken by egg collectors mostly prior to the 1930's. The diminution of those species was not noticed until the 1950's and 1960's, a result of the introduction of pesticides after World War II.

Figure 3. Nest and eggs of Horned Lark (*Eremophila alpestris*) in early March at McDonogh, Baltimore County. This species is one of the earliest of the small native birds to nest in Maryland.

In addition to the esthetic value of egg collections, they have been used in various scientific studies. When it was found that the reproduction of Chesapeake Bay Ospreys and Bald Eagles was falling off in the 1950's and 1960's, scientists began to take a look at the eggs of those species and compare them with eggs collected before the advent of DDT and other pesticides. In measuring both they found that eggs in nests of post-World War II birds that failed to hatch were broken and had thinner shells than pre-World War II collected eggs, and that pesticides were causing the egg-shell thinning.

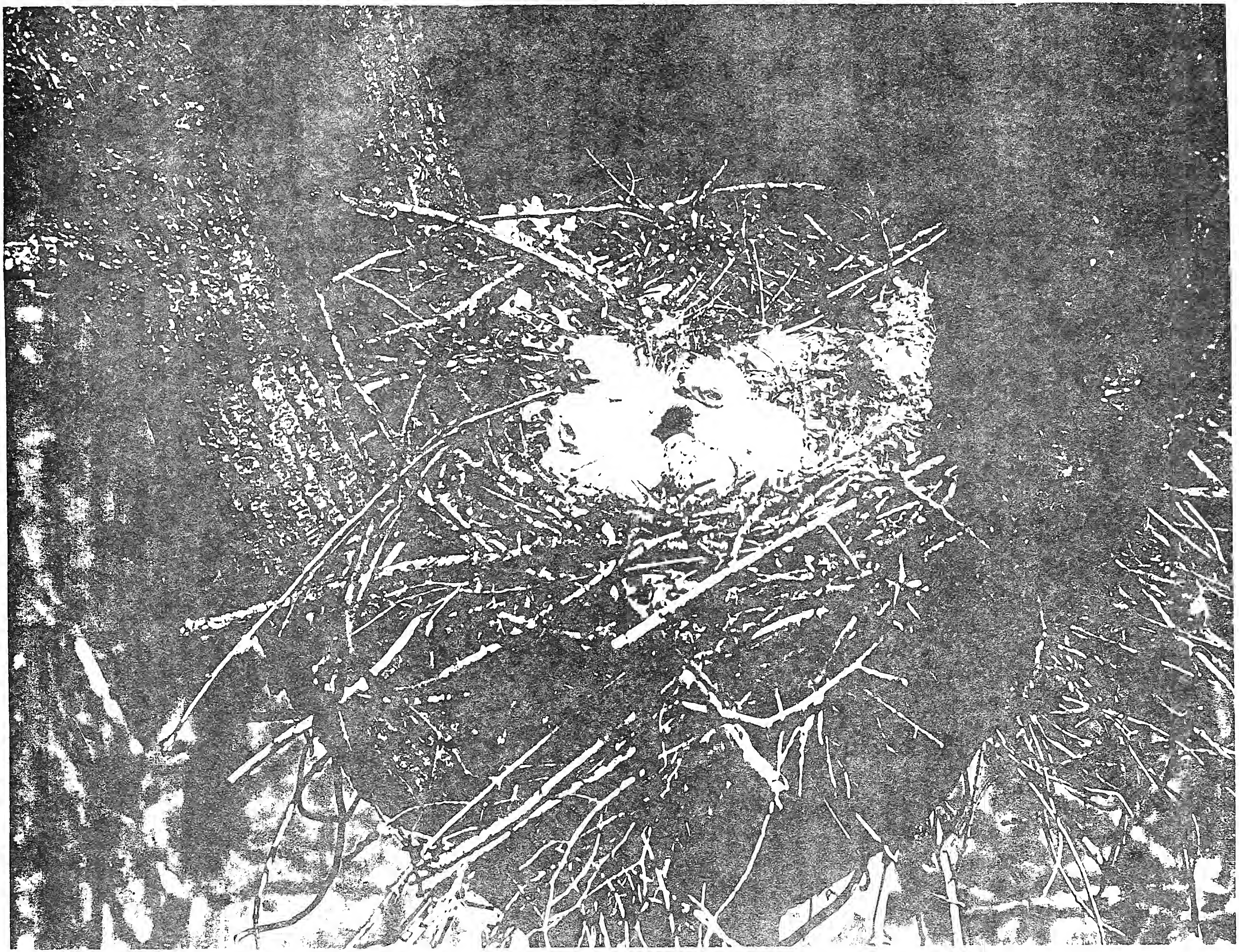

Figure 4. Young and addled egg of Red-shouldered Hawk (*Buteo lineatus*), McDonogh, Baltimore County, Maryland in April.

Figure 5. Grasshopper Sparrow (*Ammodramus savannarum*) at nest. McDonogh, Maryland. May.

Figure 6. A rare find. One of only two nests of Bachman's Sparrow (*Aimophila aestivalis*) discovered in Maryland. Beltsville, Prince George's County, 26 May 1942. This nest was found by Robert E. Stewart. E. J. Court found a nest at the same locality in 1946.

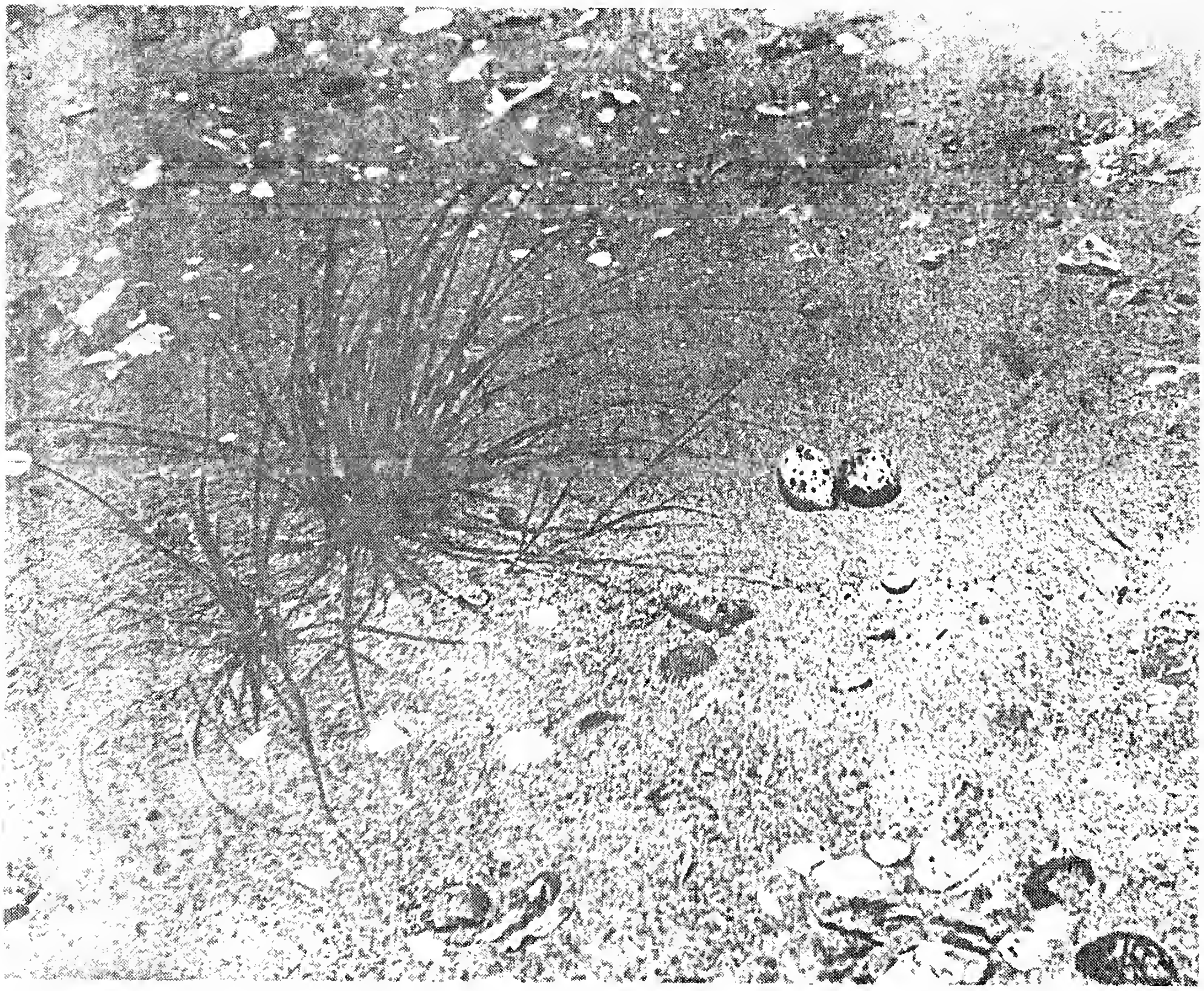

Figure 7. "Nest" and eggs of Black Skimmer (*Rynchops niger*), Assateague Island, June 1938.

Some of the Maryland egg collections have been well preserved. The John Sommer and Charles A. Rittler collections are at the Maryland Ornithological Society Headquarters at the Cylburn Mansion in Baltimore; and some of Frank Kirkwood's collection is at Columbia Union College in Takoma Park Maryland. The E. J. Court collection is probably in the U.S. National Museum in Washington, D.C. In addition, the Natural History Society of Maryland maintains another collection, primarily conposed of sets collected around Cambridge by Ralph Jackson and in Towson by J. H. Pleasents.

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Life History and Ecology of the Salt Marsh Periwinkle, *Littorina irrorata* Say (Gastropoda, Prosobranchia)

Robert W. Paul

The salt marsh periwinkle *Littorina irrorata* is a small (<30 mm long), globose snail which has a broad distribution in the continental United States (Figure 1). This snail inhabits salt marshes of the Atlantic Coast from Long Island to central Florida, and Gulf of Mexico marshes from central Florida to the Rio Grande River, Texas (Bequaert 1943). To the north of it's range, *L. irrorata* is replaced by the rocky New England coast littorines, *L. littorea*, *L. obtusata*, and *L. saxatalis* (Fell et al. 1982). From central Florida south *L. scabra angulifera*, the mangrove perwinkle, replaces *L. irrorata* as grassy coastal marshes give way to mangrove-dominated communities. Although the salt marsh periwinkle has received considerable attention in some parts of its range, reports on its ecology and life history are scattered. My purpose, here, is to review all the recently published literature on *L. irrorata* and to relate these studies to those conducted in Maryland.

The local distribution of the salt marsh periwinkle, including Maryland's Atlantic Coast and the Chesapeake Bay, is dictated by salinity and the occurance of the salt marsh grasses (*Spartina alterniflora* and secondarily *Juncus roemarianus*) in its habitat. The salt marsh periwinkle is euryhaline, but avoids salinities less than 10 parts per thousand (ppt) and greater than 45 ppt (Bingham 1972a). Bingham (1972b) also reports that *L. irrorata*'s reproductive success is limited in salt marshes with salinities averaging below 20 ppt, and Crist and Banta (1983) have shown reduced activity in *L. irrorata* when adults (>15 mm) are exposed to salinities <10 ppt and death in larger (>21 mm) snails at salinities <5 ppt. My observations (Paul unpublished) and those of Hershner (1977) and Hershner and Moore (1977) show healthy periwinkle populations in Chesapeake Bay marshes with salinities between 10 and 20 ppt. In the mainstem of the Chesapeake Bay permanent salt marsh periwinkle populations seem to be generally restricted to marshes south of the Annapolis area.

Littorina irrorata has been studied extensively in the southern part of it's range (Florida's Gulf Coast) by Bingham (1972a,b,c,d), Gallagher and Reid (1974), Hall (1973), Hamilton (1976, 1977a,b, 1978a,b), Hamilton and Winter (1982), Hamilton et al. (1983), Phifer (1976), Stirling and Hamilton (1986), Subrahmanyam et al. (1976), Warren (1985), and Wilber and Herrnkind (1982). In Alabama, studies have focused on physiology and predation (Pamatmat 1978, West and Williams 1986; respectively) while those conducted in Louisiana have examined periwinkle abundance (Day et al. 1973), diet (Alexander 1979), and respiration (Shirley and Findley 1978, Shirley et al. 1978). *L. irrorata* collected from Mississippi have been analyzed for their zinc content (Ireland 1983).

Atlantic Coast studies include those conducted in Georgia (Kraeuter 1976, Smalley 1959, Targett and McConnell 1982, Turner 1987), and in North Carolina (Baxter 1983, Cammen et al. 1980, Stiven and Hunter 1976, Stiven and Kuenzler 1979, Thiriot-Quievreux 1981). Several studies of *L. irrorata* have been conducted in, or on samples from, the marshes of the Virginia Atlantic Coast (Bleil and Gunn 1978, Blundon and Vermeij 1983, Crist and Banta 1983, Reidenbaugh 1978, Stanhope et al. 1982). In Virginia salt marshes of the Chesapeake Bay, Hershner (1977) and Hershner and Moore (1977) studied the effects of oil pollution on *L. irrorata*. Studies of Maryland *L. irrorata* to my knowledge are limited to five investigations. Two early works (Newcombe and Gould 1937, Phillips and Newcombe 1937) examined the growth of *L. irrorata*. Allen (1952) described the mouth parts of the salt marsh periwinkle, and a brief report by Allen (1954) mentions *L. irrorata* in gastropod samples from Crisfield, Maryland.

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Finally, Paul et al. (in press) described *L. irrorata* behavior and respiration during winter hibernation.

Figure 1. *Littorina irrorata* ascending a grass stem, and the distribution of *L. irrorata.*

LIFE HISTORY

Littorina irrorata, like the other members of the Family Littorinidae, are dioecious, that is at maturity individuals are distinctly female or male and not, as are many other gastropods, protandrous (changing of sex). My studies (Paul in prep) show that the marsh periwinkles inhabiting Maryland marshes reach sexual maturity when they attain a length of 10-15 mm. This confirms Hamilton's (1978b) observation that breeding begins when Florida snails are approximately 13 mm long. Bingham (1972d), however, reported that sex could be determined in Florida *L. irrorata* at 6 mm, but he did not report the size at which copulation begins. In Maryland copulation starts in late spring and continues until early fall, with the peak of activity in mid-summer (Paul unpublished). Likewise, in Georgia, Smalley (1959) observed that breeding began in June with spawning beginning in July. In Florida, *L. irrorata* breed throughout the year, but copulation is rare in winter and greatest during the spring and summer (Gallagher and Reid, 1974). In this same study it was reported that *L. irrorata*'s copulation and spawning were correlated with a bi-lunar periodicity and daily tidal rhythm. Bingham (1972d) suggests that high temperature is the stimulus for copulation.

Copulation in *L. irrorata* occurs near the water's edge either on the stems of *Spartina alterniflora* (Bingham 1972d) or on the marsh mud (Hamilton 1978b). The male crawls to the right side of the female's shell and inserts his penis into the mantle cavity and opening of the oviduct. Copulation takes less than an hour and pairs then immediately separate (Bingham 1972d, Gallagher and Reid 1974). In Gallagher and Reid's (1974) study spawning took place during and a few days following new and full moon phases at high tide while females were underwater. Spawn release was observed by Gallagher and Reid (1974) for 2-4 successive days with 1-2 1/2 hour, continuous spawning periods and was also seen by Bingham (1972d) for 2-4 hour periods. *Littorina irrorata* releases simple, pelagic, bi-convex capsules containing one fertilized egg. A single female may discharge 15,000-32,000 eggs in a single spawning period (Gallagher and Reid 1974) or as many as 43,000-85,000 during the longer spawning period observed by Bingham (1972d).

Egg development and hatching is dependent on salinity (Bingham 1972b) and temperature (Gallagher and Reid 1974). *Littorina irrorata* veligers (larva) hatch from egg capsules after 27-40 hours at 26-28°C or in 53-56 hours at 22-24°C when maintained at 34-35 ppt (Gallagher and Reid 1974). The veligers, after hatching from the egg, spend approximately 20-60 minutes swimming in the egg capsule, then break the capsule and enter the water (Gallagher and Reid 1974). Veligers then are at the mercy of tides and currents, although they have limited swimming ability, and they remain suspended in the water column until their shells have 3.5 to 4 whorls (Smalley 1959). Veligers with 1.5 whorls are found in the plankton of North Carolina waters during summer (Thiriot-Quievreux 1981), and in Georgia, veligers were found in the plankton during July and August but were absent in September (Smalley 1959). Apparently, the acretion of shell and increased shell density causes the veligers to settle from the water column. It is not known whether the small salt marsh periwinkles settle directly on *Spartina* plants or later ascend the stems (Smalley 1959). Presumably, for protection, the young juveniles (< 5 mm) move to the base of dead and curled *S. alterniflora* leaves, just distal to the ligule (Crist and Banta 1983). The smallest snails observed by Smalley (1959) were 0.8-1.0 mm and they were never found on the marsh mud. He estimates that for the first 9-12 weeks of their lives in marshes these very small snails remain on the first plant they encounter.

The co-occurance of *L. irrorata* and *S. alterniflora* is well documented. Hamilton (1978b) and West and Williams (1986) found a strong correlation between the distribution of *S. alterniflora* and *L. irrorata*. Hamilton (1978b) states that *L. irrorata* displacement from vegetation by wave action is probably uncommon and that once displaced, the snails would presumably attempt to return to vegetated areas (Hamilton 1978a). Bingham (1972b) reports that *L. irrorata* is not found in marsh areas barren of higher plants, and this is true of extensive marsh mudflats in Maryland that are some distance from *S. alterniflora* stems (Paul unpublished). It is also clear from the literature that the *S. alterniflora* is important in the life cycle of *L. irrorata* and in maintaining viable, reproducing populations of *L. irrorata*. It is less clear how *L. irrorata* can survive on the bulkheads and shoreline erosion control materials common in Maryland. These structures lack higher plants and are often considerable distances from *Spartina* marshes, and yet they support large *L. irrorata* populations (Paul unpublished). Therefore, the specific role of *S. alterniflora* in *L. irrorata* settlement and the snail's ability to colonize certain habitats remains unclear. Gallagher and Reid (1974) studied *L. irrorata* on seawalls and in a *Spartina* marsh, and noted a larger mean length of both *L. irrorata* and *L. scabra angulifera* in the marsh, but to my knowledge no study has addressed *L. irrorata* population establishment in grass-free environments. There also seems to be a paucity of information, in general, on *L. irrorata* settlement.

ECOLOGY AND BEHAVIOR

Snail density and zonation

In salt marshes *L. irrorata* occupy elevations between mean tide level (MTL) and mean high water (MHW) (Crist and Banta 1983), a zone which roughly corresponds to the *S. alterniflora* zone (Hamilton 1978b). The distribution of snails in the *Spartina* zone is patchy and contagious. Clumps of juvenile snails can push snail densities to greater than 700 snails/sq. meter (Smalley 1959). In Fisher's Creek marsh (St. Mary's City, MD) I have found *L. irrorata* densities to be as high as 756 snails/sq. meter with juveniles (<10 mm) making up over 40% of this sample (Paul in prep).

Gastropod zonation by size class across the intertidal zone is common and well studied, and *L. irrorata* has a specific zonation. The pattern of *L. irrorata* zonation is, however, obscured by conflicting reports. Smalley (1959) found few snails in his stream-side (tall *S. alterniflora*) plots, but snails were abundant in his "high" marsh (short *S. alterniflora*) plots which were located near MHW and not adjacent to tidal creeks. Bingham (1972b) reported peak snail densities between mean sea level (MSL) and MHW with few snails <5 mm near the water's edge. Hamilton (1978b), on the other hand, found high densities of small snails (5-13 mm) close to MSL and larger snails (>13 mm) concentrated near MHW. The opposite pattern is reported by West and Williams (1986) in Alabama who found the largest *L. irrorata* near mean low water (MLW) and MSL, and smaller snails making up a greater percentage of the population at MHW. West and Williams (1986) did not, however, sample snails <9 mm.

In a Virginia marsh, Crist and Banta (1983) found yet another pattern. They report high concentrations (>300 snails/sq. meter) of small (<5 mm) snails very near MTL with the largest snails occupying a zone immediately above the smallest snails. The pattern observed by Crist and Banta (1983) has also been observed by Baxter (1983), Stiven and Hunter (1976) and Stiven and Kuenzler (1979). The pattern I (Paul in prep) have observed in Fisher's Creek marsh is most similar to that reported by Crist and Banta (1983). *Littorina irrorata* and *S. alterniflora* at my study site are restricted to a very narrow zone from slightly below MTL (the *S. alterniflora*-creek edge junction) to points 2-8 m upshore (MHW). The largest snails are located near MTL (1.5-2.0 m upshore from the creek edge). I have also observed some seasonal shifts in size classes relative to elevation.

The confusion over the different size class distribution patterns in *L. irrorata* across the intertidal zone is probably the result of different sampling and size classification methods employed by investigators and the variability in marsh elevations and slopes at the various study sites. Baxter (1983) has shown that elevational gradients influence the growth form of *S. alterniflora* which, in turn, influence *L. irrorata* density. The density differences with elevation I have observed may be a result of a steeper elevational gradient in Fisher's Creek marsh as compared to that in Cow Gut Flat, Virginia (Crist and Banta 1983). In general, marsh elevation, micro-topographical relief features, and marsh grass distribution/growth form (Baxter, 1983) are the primary factors controlling *L. irrorata* distribution within a marsh.

Vermeij (1972) in reviewing intertidal gastropod distribution across elevation gradients has devised a generalized classification scheme. A type 1 distribution is characterized by shell length increasing upshore (higher tidal elevation) and a type 2 distribution has snail shell length decreasing upshore (Figure 2). According to Vermeij, those gastropods with type 1 distributions probably have higher mortality rates among small individuals at higher elevations because of the physical extremes of temperature, humidity and salinity. Type 1 distributions are common among species living in the high intertidal zone. By contrast, Vermeij states that those

gastropods occupying lower intertidal zones would have type 2 distributions. The larger size classes would be located lower in the intertidal because smaller size classes (postlarval, prereproductive snails) would be subject to differential mortality rates from biological interactions such as competition and predation.

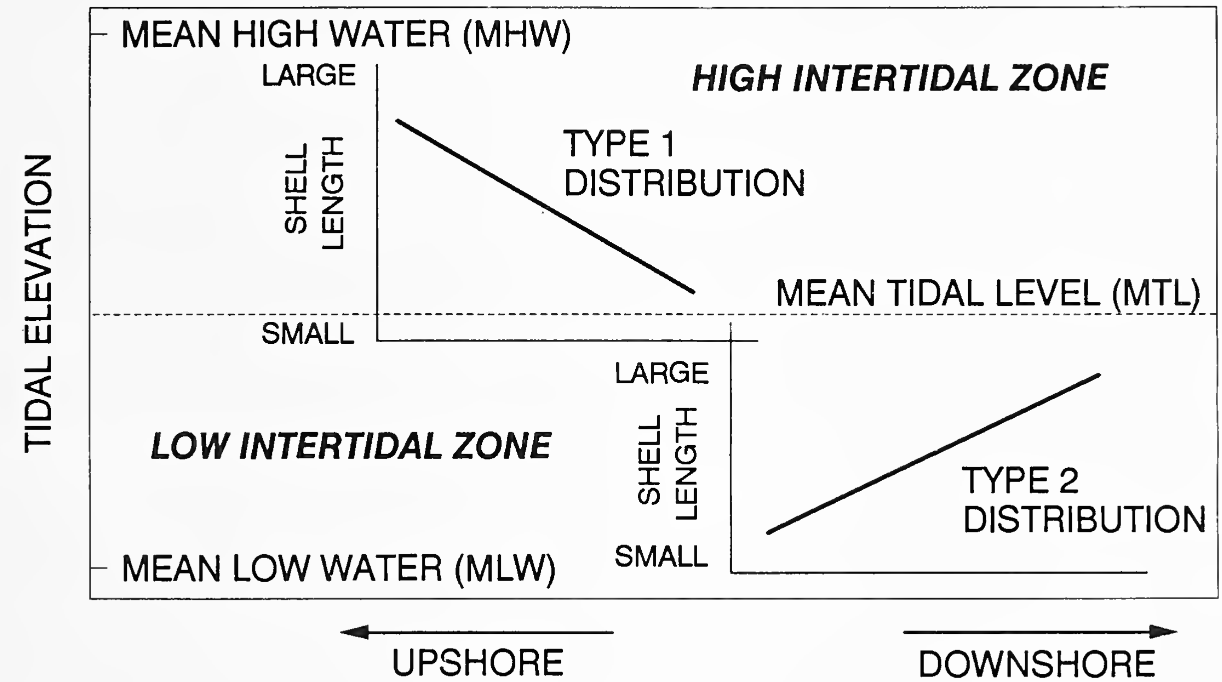

Figure 2. Generalized distribution of gastropod size classes across the intertidal zone according to Vermeij's (1972) model of shore-level gradients. See text for explanation.

Although Vermeij (1972) does not specifically classify *L. irrorata*, a type 1 distribution might be expected for these snails because they occupy the high intertidal zone. This seems to be the case as Hamilton (1978b), Christ and Banta (1983), my unpublished studies, and those of others point out. However, when I consider all size classes of the salt marsh periwinkle at St. Mary's City, shell length decreases slightly in an upshore direction (a type 2 distribution characteristic). This anomaly is due to the fact that both juvenile and the largest *L. irrorata* are concentrated near MTL, and it is probably meaningless to consider all *L. irrorata* size classes together as Crist and Banta (1983) assert. It is probable that *L. irrorata* has a type 2 distribution similar to that of *L. littorea*, although there is considerable variation in the zonation of this species as well (Vermeij 1972). Maintenance of this type 2 distribution by *L. irrorata*, in my estimation, is due to two factors: 1) the refugia from potential snail predators for small (<5 mm) snails in the curled *S. alterniflora* leaves, thus enabling these snails to maintain their positions near MSL and 2) the vertical migration of larger size classes up *S. alterniflora* stems on approaching flood tides, thus avoiding potential predators.

Size distribution

In marshes, *L. irrorata* range in length from 0.8 mm (Smalley, 1959) to 29.5 mm (Paul in prep). Because dissolution and wear reduce overall shell length, the *L. irrorata* with the longest shells are not necessarily the oldest snails (Paul unpublished). Change in shell shape (allometry) with age has also been well documented for other littorines (eg. *L. nigrolineata* and *L. rudis,* Heller 1976; *L. rudis, L. littorea,* and *L. obtusata,* van Marion 1981), and these findings suggest to me, and even earlier to Phillips and Newcombe (1937), that shell width may be a better measure of age. Despite this observation, most authors have found it convenient to use shell length in describing *L. irrorata* size classes and growth.

Maximum shell length seems to be slightly shorter in southern populations of *L. irrorata.* For example, Smalley (1959) reports 21.0 mm as his largest snail, Hamilton (1978b) 22.0 mm, and Bingham (1972b) notes 20.5 mm, but he (Bingham 1972c) also reports females longer than 20.6 mm from the same location and Gallagher and Reid (1974) found females longer than 24.0 mm. Both studies, however, fail to give maximum shell lengths. By contrast West and Williams (1986) report 24.0 mm snails in North Carolina marshes. Christ and Banta (1983) obtained a 28.0 mm snail in their study, and they state that 29.0 mm snails are occasionally encountered in their Virginia marsh. In my extensive Maryland sampling (Paul in prep), snails longer than 27 mm are uncommon, but a single individual has been collected with a 29.5 mm shell length. It is possible that a slight north-south gradient of maximum shell length exists, with larger snails occupying more northly habitats.

Length to width (L/W) ratios are reported by Bingham (1972c) who found, as did Bequaert (1943), only minor variations in shell shape across *L. irrorata*'s range. Bingham's L/W ratios ranged from 1.49 in Panama City, Florida to 1.63 in Beaufort, North Carolina. My studies show a considerably lower L/W ratio of 1.29 for St. Mary's City snails, a ratio which is the same when juveniles (<10 mm in length), males, and females are considered separately. Sexual dimorphism in shell size has also been reported by Bingham (1972b) and Hamilton (1978b) for Florida snails. Both found that females were larger than males, but these observations were made on small samples. My more detailed examination of snail size distribution by sex (to be published in a separate paper) indicates that females tend to be more numerous than males in certain size classes (10-18 mm and > 20 mm). In the marsh I study, females have a slightly greater mean length than males, and they out number males by nearly 2 to 1. Whether female *L. irrorata* grow at faster rates, are less subject to predation, or have a greater longevity when compared to males are points which remain uninvestigated.

In general, the size frequency distributions for *L. irrorata* reported by researchers are surprisingly similar. When individuals are grouped into 1 mm shell length size classes and the frequency of size classes plotted (Figure 3), a skewed distribution is the usual result. The highest frequencies occur between 20 and 21 mm. A prominent depression in frequency has been noted by many investigators (Crist and Banta 1983 at 15 mm, Hamilton 1978b at 13 mm, Stanhope et al. 1982 at 16-17 mm, and West and Williams 1986 at 14 mm). My studies show this depression to be quite variable (between 9 and 18 mm) depending on the year or season in which the sample was obtained (Paul unpublished), however, this depression of snail numbers is consistantly near the center of the size distribution. Several studies (Hamilton 1976, Stanhope et al. 1982, West and Williams 1986) have shown that the blue crab (*Callinectes sapidus)* is a size-selective predator of *L. irrorata,* and that the crabs select intermediate-size snails. These findings suggested to West and Williams (1986) that the size frequency depressions of intermediate-size snails, which they observed, was due to crab predation and the frequency of tidal inundation.

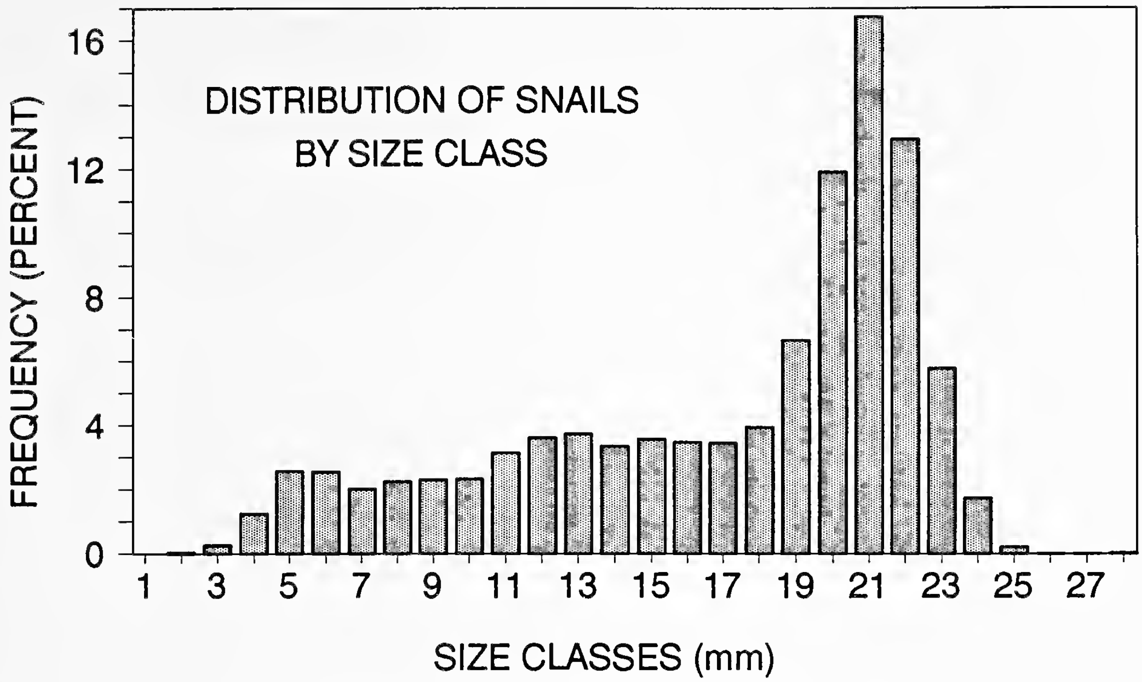

Figure 3. Generalized frequency distribution of individuals in 1 mm size class intervals for a *L. irrorata* population.

Growth

Littorina irrorata growth rates reported in the literature are contradictory and confusing. Bingham (1972c) states that Florida salt marsh periwinkles grow to 20 mm in length in 20 months, but Hamilton (1978b) reported an annual growth rate of only 0.40 mm/year for adults. Young *L. irrorata* grow at faster rates than older snails (Bingham 1972c) and their growth rates as juveniles seem to be controlled, in part, by the density of *S. alterniflora* litter (Stiven and Hunter 1976, Stiven and Kuenzler 1979) and their own density (Smalley 1959, Stiven and Hunter 1976, Stiven and Kuenzler 1979).

In Georgia (Smalley 1959) tracked the growth of small snails for 21 months, making his study the longest, sustained observation of a *L. irrorata* year class. During this period, snails initially 2 mm long only grew slightly more than 6 mm when all his samples were considered. Those samples with the highest initial densities grew at the slowest rates (5.28 mm), while those snails in areas with lower densities grew at the fastest rates (6.78 mm). Since the variable growth rates reported by Smalley (1959) were correlated with density and marsh elevation, he attributed the differences in growth rate to the number of juveniles which successfully settled and became established in the marsh. Likewise, Baxter (1983) found differential *L. irrorata* growth rates due to differences in the topography and vegetative structure of a North Carolina marsh. Stiven and Hunter (1976) found 3 different growth rates for the salt marsh periwinkle in the 3 different marshes they studied in North Carolina. Using shell width, they reported linear growth rates which range from approximately 3.0 to 4.8 mm(width)/year for snails initially 6 mm wide to less than 1 mm/year for snails wider than 12 mm. If the length/width ratio reported by Bingham

1972c) for Beaufort, NC (1.63) is applied to Stiven and Hunter's (1976) growth rates, then annual increases of 4.9 to 7.8 mm in length would be expected for North Carolina snails intially 9.8 mm long (6 mm wide). These rates are approximately half those stated for Florida snails initially 11.2 mm long which grew 6.3 mm in 5 months (Bingham 1972c). Like Smalley's (1959) and Stiven and Kuenzler's (1979) reports, these highest growth rates were observed where initial snail density was the lowest.

It is clear that juvenile *L. irrorata* (< 15 mm in length) grow faster than adults and that adult growth slows substantially as snails exceed 15 mm. If Stiven and Hunter's (1976) growth equations and Bingham's (1972c) L/W ratio are correct then snails would reach a length of 26.1 mm and a width of 16.0 mm in 7.5 to 8.5 years.

Mortality rates reported for *L. irrorata* are also confusing. Smalley (1959) reports a 24 snail reduction/sq. meter/month in his Georgia marsh, while annual mortality rates between 11 and 74% were obtained in controlled experiments with different *S. alterniflora* litter and *L. irrorata* densities (Stiven and Hunter 1976) and between 45 and 89% when the densities of *S. alterniflora* litter, *L. irrorata,* and *Geukensia demissa* (a mussel) were manipulated (Stiven and Kuenzler 1979). The highest mortalities occurred in plots with the highest litter and greatest initial mollusc densities.

Mortality due to predation has also been reported to be as high as 47.8% in 14-18 mm snails experimentally caged with blue crabs (West and Williams 1986) and 31.6% in 13-20 mm periwinkles teathered near the marsh surface (Warren 1985). In Virginia, Stanhope and her colleagues (1982) found that starved blue crabs were almost entirely successful in breaking 5-15 mm snails, but her experiments were carried out under controlled laboratory conditions. A strong correlation exists between crab size and the size of *L. irrorata* eaten. Hamilton's (1976) study showed that his relatively large crabs (55-65 mm carapace length) consumed intermediate-size (12-15 mm) snails, but these crabs discarded larger (>15 mm) snails. Blue crabs, therefore, have an influence on the mortality of *L. irrorata,* but the extent of deaths due to predation versus other natural causes in natural populations remains unknown. Whether the universal depression in the frequency of *L. irrorata* between 9 and 18 mm is due to a size-specific mortality in these size classes as a result of predation, size-specific death, or simply a change in the snail's growth rate needs further investigation.

Behavior

One of the most interesting aspects of the salt marsh periwinkle is its behavior. Many of the previously cited papers have focused on *L. irrorata*'s orientation, vertical migration, and physiology. Bingham (1972b) showed that *L. irrorata,* under normal conditions, is positively phototaxic and negatively geotaxic, and even more negatively geotaxic when submerged. On approaching flood tides, *L. irrorata* ascend grass stems where they remain until the ebb tide allows them to return to the marsh floor. Bingham (1972b) also reported that desiccation followed by salt water wetting and high temperature initiated a downward movement (positive geotaxis) in *L. irrorata.*

A host of studies have examined various aspects of *L. irrorata*'s vertical migrations with each tidal cycle. Hamilton (1977a, 1978a), Hamilton and Winter (1982), and Hamilton et al. (1983) found that *L. irrorata* can see fairly well and orient specifically toward plant stems. Bleil and Gunn (1978) showed that the climbing behavior was not to avoid drowning since the salt marsh periwinkle can withstand long periods (6 weeks) of submergence. The most plausible explanation for the vertical migrations is to avoid water-borne predators arriving on flood tides, ie. the blue crab (Blundon and Vermeij 1983, Hamilton 1976, Stanhope et al. 1982, Warren 1985, West and Williams 1986) or, on the Gulf Coast, blue crabs and crown conchs, *Melongena corona*

(Phifer 1976, Wilber and Herrnkind 1982). Stanhope and her colleagues (1982) state, however, that only 25% of the periwinkles in their study left the water during high tide. This contrary to the notion that vertical migration is a predator avoidance behavior and suggests to me that the importance of water-borne predators in initiating a vertical migration response in *L. irrorata* may be overstated by some investigators.

For example, the high blue crab predation rates on *L. irrorata* reported by West and Williams (1986) may have been an artifact of the experimental design which enclosed blue crabs in cages with salt marsh periwinkles. Likewise, Warren's (1985) experiments in which *L. irrorata* were teathered to the substrate were inconclusive, and showed a predation rate by blue crabs which was the same whether or not the snails were kept near the marsh surface. When Stiven and Hunter (1976) and Stiven and Kuenzler (1979) excluded predators by caging *L. irrorata*, mortality rates were still very high. It, therefore, appears likely that the threat of predation is one of the pressures which elicit the migration response of *L. irrorata*, but this pressure is not particularly strong. I also believe that *L. irrorata* size class distribution with tidal elevation is not as strongly influenced by crab predation as Crist and Banta (1983) state.

Once the snails have ascended stems, they frequently (under low humidity and/or extreme salinity conditions) form holdfasts, small amounts of mucus anchoring their shell lips to the grasses. When holdfasts are formed the snail withdraws into the shell and closes its operculum. Holdfast formation apparently gives *L. irrorata* the ability to conserve energy while maintaining its position during high tide (Bingham, 1972a). On the ebb tide *L. irrorata* scrape away holdfasts and move to the marsh floor, foraging and feeding on plant detritus or algae (Alexander 1979, Smalley 1959, Stiven and Kuenzler 1979).

With my collegues, I (Paul et al. in press) have studied *L. irrorata* behavior and respiration during winter. Although two studies (Hershner 1977, Smalley 1959) mention the lack of *L. irrorata* activity during winter, no previous studies have actually examined *L. irrorata*'s behavior or physiology under adverse winter conditions. This is, presumably, because a reduction in activity is not prominent in the milder, southern extent of *L. irrorata*'s range or because studies have been limited to the milder months of the year. In Maryland, when the daily maximum temperature falls below 13°C, *L. irrorata* hibernate. As air temperatures approach 13°C snails take a spire-down position near the base of *S. alterniflora* stems and seemingly attempt to burrow into the marsh mud. Their burrowing success is limited, and they can only penetrate the marsh mud to about one half of their spire length. Therefore, clumps of up to 30 snails are found clustered around grass stems. The snails remain in these positions throughout the winter until air temperatures exceed 11-13°C and they resume their activity. At temperatures less than 16°C, *L. irrorat*a lower their respiration rates to levels below those that would be expected by temperature reduction alone, a true hibernation. It is also interesting that closely-related *L. littorea*, seems to have the same change in respiration rate at approximately the same temperature (Newell 1979).

CONCLUSIONS

The salt marsh periwinkle (*Littorina irrorata*) is a fascinating organism studied extensively in the southern part of its range. By contrast, surprisingly little work has been done in its northern habitats, especially in the Chesapeake Bay and Maryland. Such studies would be most interesting because these habitats are potentially more physically rigorous and theoretically present a different set of problems for *L. irrorata*. The outcomes of experiments with *L. irrorata* in Maryland would be useful in understanding how this organism is limited by its environment, how it is adapted to the unique features of its local environment, and how these responses are or are not related to southern *L. irrorata* populations.

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Unusual Abundance of the Aquatic Liverwort *Ricciocarpus natans* (L.) Corda at Prettyboy Reservoir, Baltimore County, Maryland

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During May 1987, Prettyboy Reservoir in Baltimore County, Maryland experienced an unusual abundance of the aquatic liverwort *Ricciocarpus natans* (L.) Corda. During eight years of monthly water quality monitoring at Prettyboy, this is my only observation of this phenomenon.

Prettyboy Reservoir is located on the Gunpowder Falls in northern Baltimore County, Maryland (Figure 1). Prettyboy Dam was completed in 1932 and impounds a maximum of 75.7 million cubic meters of water, with a surface area of approximately 607 hectares at a crest elevation of 158.5 meters above mean sea level.

I first observed *R. natans* on 11 May 1987. From a distance the plants appeared to be extensive mats of blue-green algae covering much of the open surface of the reservoir. This in itself would have been unusual for this time of the year. However, closer examination showed the mats to be composed entirely of *R. natans*. On 13 May 1987, I returned to Prettyboy and surveyed the entire reservoir to determine the extent of the liverwort's coverage. On that date easterly winds had caused the liverworts to be concentrated along the windward and leeward sides of the reservoir. Along much of the windward shore, *R. natans* formed a band extending 0.3 meters from the shoreline out onto the surface of the water and 0.3 meters up onto the shore. This band ranged up to 3 centimeters thick. In some windward coves *R. natans* formed floating mats approximately 2.5 meters by 4.0 meters in size. Figure 1 shows Prettyboy Reservoir divided into three zones based on the abundance of *R. natans*. In the abundant zone, the liverwort could readily be found anywhere along the shoreline; in the sparse zone, a little searching was required to find plants; and in the absent zone, none were found. A survey of the reservoir the following month, on 22 June 1987, showed no evidence of *R. natans*.

Ricciocarpus natans is a thalose aquatic liverwort. It is widely distributed throughout the world in temperate and subtropical regions (Steere 1940). In North America, it occurs throughout the United States and extends into Canada from British Columbia to Quebec (Schuster 1953). *Ricciocarpus natans* occurs primarily on still ponds, pools, lakes, canals, and along streams and rivers, including their backwaters (Schuster 1953). Aquatic habitats inhabited by this liverwort have been described as warm, shallow, stagnant, poor in lime, circumneutral to slightly calcareous, and containing much nitrogenous matter (Gams 1932, Hotchkiss 1967, Schuster 1949).

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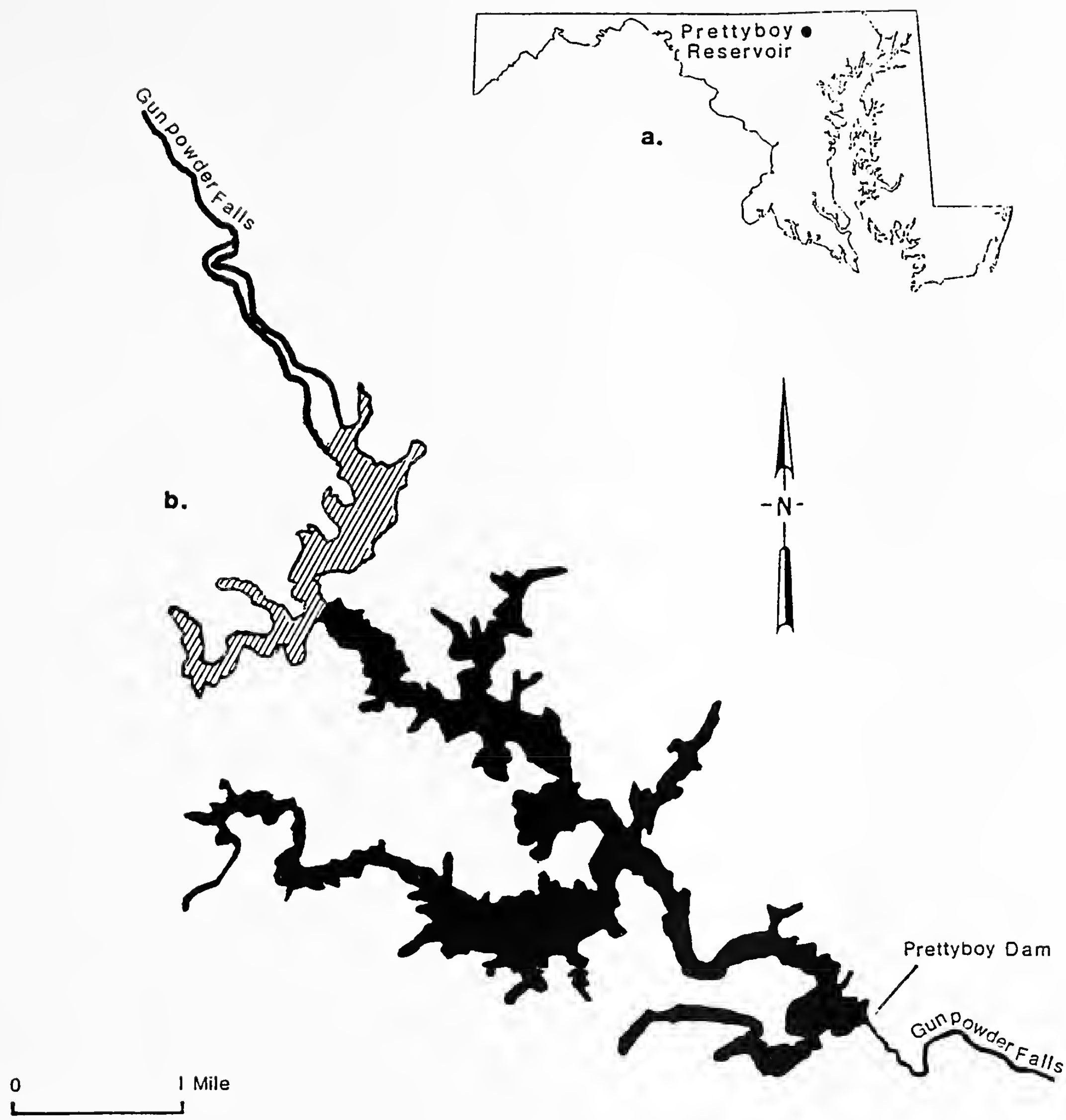

Figure 1. Prettyboy Reservoir, showing distribution of *Ricciocarpus natans* on 13 May 1987 (black=abundant, striped=sparse, plain=absent).

Ricciocarpus natans is often found growing in association with the duckweeds *Lemna, Wolffia,* and *Spirodella* (Schuster 1957), the waterfern *Azolla* (Allison and Child 1975), and the other North American thalose aquatic liverwort, *Riccia fluitans* L. (Schuster 1949). During dry summers, *R. natans* frequently becomes stranded on wet soil around drying pools and along stream margins (Schuster 1953) but continues to grow terrestrially in a slightly modified form (Steere 1940).

Extensive colonies of *R. natans* have been reported by Schofield (1985) and Watson (1981). Watson stated that in some areas, *R. natans* forms such dense surface scums that it may upset freshwater fish habitat. The reason for the tremendous population increase at Prettyboy Reservoir in 1987 is unknown. However, it may be linked with very low water levels that occurred during the summer and fall of the previous year. Those levels were the lowest recorded since a severe drought in the mid 1960's, during which the reservoir was nearly drained. During October of 1986, water levels in the reservoir dropped to 8.3 meters below the crest and exposed an extensive area of reservoir bottom to the air.

Support for the hypothesis of low water level is given by McGregor (1955) who reported that *R. natans* stranded on exposed bottom surfaces develop into the terrestrial form during summer and early fall. Then, with the fall rains, they become submerged and remain on the bottom throughout the winter. In the spring, the apical tips produce small plantlets which detach and float to the surface to grow into fruiting plants.

This suggests that if Prettyboy Reservoir should experience extremely low water levels again, *Ricciocarpus natans* may once more become temporarily abundant at the surface.

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An Assessment of Local Delmarva Fox Squirrel Populations

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The Delmarva fox squirrel (*Sciurus niger cinereus*) is an endangered subspecies. Its historic range included the entire Delmarva Peninsula of Maryland, Delaware, and Virginia, portions of southeastern Pennsylvania, and parts of southern New Jersey (Taylor 1973). By the time it was listed as endangered in 1967, its range had contracted to four counties in Maryland, including Dorchester, Kent, Queen Anne's, and Talbot (Taylor and Flyger 1973).

In 1971 Taylor determined the locations of Delmarva fox squirrel populations through interviews with local residents, farmers, biologists, game wardens, foresters, and others having knowledge of this squirrel (Taylor 1976). From those interviews, he believed 61 sight records to be valid. Taylor (1976) also selected 54 sites, 36 of which supported fox squirrels and 18 which supported only gray squirrels (*S. carolinensis*), to test for differences between sites inhabited by these species.

Since there was no quantitative data available on a rangewide basis to assess the population status of the Delmarva fox squirrel since it was listed, we decided that Taylor's (1976) 54 sites should serve as the basis for assessing the squirrel's current (1988) status. Thus, the objectives of this study were to determine habitat changes to Taylor's (1976) study sites and assess the current population status of Delmarva fox squirrels at each site. Additionally, annual extinction and colonization rates were to be determined so as to infer rangewide status.

Study Area and Methods

The study sites were located in five Eastern Shore counties, including Caroline, Dorchester, Kent, Queen Anne's, and Talbot. The sites were generally combinations of forest and agricultural lands. The forests were hardwood stands predominated by oaks (*Quercus* spp.), hickories (*Carya* spp.), and beech (*Fagus grandifolia*), or mixed forests of hardwoods and loblolly pine (*Pinus taeda*). Fox squirrel present sites had larger trees, less shrub-ground cover vegetation, and less understory development than did fox squirrel absent sites (Dueser et al. 1988).

The methods used to determine habitat changes and fox squirrel population status at each site were similar to those used by Taylor (1976). Interviews were conducted with each site's landowner, who was asked if significant changes had occurred on the property since 1971 (e.g. timber harvesting) and what those changes were. The landowner was also asked if fox squirrels were present on the site and how they would

compare the population today with that of the early 1970's. Additional information was obtained from game wardens, biologists, and others familiar with these sites. Each site was also visited in November 1988, and a visual assessment of habitat conditions was made. Changes in land use were noted, as was the suitability the property for supporting fox squirrels.

Annual extinction and colonization rates were estimated by the following equation:

$$r = \frac{\underline{(c/n)}}{17}$$

where: r = extinction or colonization rate.

c = number of fox squirrel present or absent sites where population status changed between 1971 and 1988.

n = number of fox squirrel present or absent sites.

17 = number of years between studies.

Results

Of the 36 fox squirrel present sites, 75% were unchanged, 11% had some timber cut since 1971, and habitat for the fox squirrel had been improved on one site (Table 1). Only one site was determined to no longer have Delmarva fox squirrels present. This site was on private property located at the periphery of the squirrel's known range, and had experienced no habitat alteration. Most landowners reported higher fox squirrel populations on their properties than in 1971. However, Blackwater National Wildlife Refuge reported fewer fox squirrels than in 1971. Reasons for this are unknown, although changes in agricultural practices may have contributed.

Of the 18 fox squirrel absent sites, 72% remained unchanged, timber had been harvested on 22%, and one site had experienced severe gypsy moth (*Lymantria dispar*) damage (Table 2). One site had been naturally colonized by Delmarva fox squirrels, one site had served as a reintroduction site, and an unconfirmed report of fox squirrels was obtained for another site. The naturally colonized site was on state owned land at the periphery of the squirrel's occupied range.

An annual extinction rate of 0.002 was calculated from the 36 fox squirrel present sites over the 17 year period, while the annual colonization rate was estimated at 0.003 (based on the one known natural colonization).

Table 1. Status of Delmarva fox squirrel present sites (Taylor 1976) as determined by site visit and interviews in 1988.

	County	Land Use Changes	Reported DFS Pop. Status
Angell Farm	Dor.	none	present
Ashby Farm	Talbot	none	good
Baker Farm	Dor.	none	high
Beechwood Farms #1	Talbot	none	high
Beechwood Farms #2	Talbot	none	high
Beechwood Farms #3	Talbot	none	high
Blackwater NWR	Dor.	improvements	decreased
Bow Knee Point	Talbot	none	high
Bucktown Farm	Dor.	some cutting	present
Compton Farm	Talbot	some nearby dev.	high
DuPont Farm	Talbot	none	high
German Branch & Rt. 304	Q.A.	none	absent
Hampden Farm	Talbot	none	present
Hope House Farm	Talbot	none	high
Horn Point	Dor.	some cutting	low
Ingersoll Farm	Talbot	some nearby dev.	present
Kentuck Swamp	Dor.	limited cutting	high
Kellogg Farms #1	Talbot	none	high
Kellogg Farms #2	Talbot	none	high
Kirby Wharf Farm	Talbot	none	increased
LeCompte WMA	Dor.	none	high
Lewis Smith Farm	Talbot	none	increased
Mill Creek Sanctuary	Talbot	none	present
Newcomb Farm	Talbot	none	high
Phillips Farm	Dor.	none	increased
Schnoor Farm	Talbot	none	present
Stone Ledge Farm	Dor.	nearby cutting	high
Vickers Farm	Dor.	none	high
Woodlot at Rt. 213 & 309	Q.A.	some dev.	present
Wye Institute #1	Q.A.	none	high
Wye Institute #2	Q.A.	none	high
Wye Island	Q.A.	very limited	high
Wye Plantation #1	Talbot	none	high
Wye Plantation #2	Talbot	none	high
Wye Plantation #3	Talbot	none	high
Wye Plantation #4	Talbot	none	high

Discussion

Results of this assessment indicate that the Delmarva fox squirrel population has not declined since it was listed as endangered. There was one local extinction, but also at least one local colonization over that 17-year period. The estimated annual extinction and colonization rates were nearly identical. This suggests a stable rangewide population under the prevailing land management over the past 17 years.

Table 2. Status of Delmarva fox squirrel absent sites (Taylor 1976) as determined by site visit and interviews in 1988.

	County	Land Use Changes	Reported DFS Pop. Status
Delahay Farm	Talbot	none	absent
Dover Road Farm	Talbot	heavy cutting	absent
Follinsbee Farm	Talbot	some cutting	absent
Hickory Ridge Farm #1	Talbot	none	absent
Hickory Ridge Farm #2	Talbot	some cutting	absent
Hickory Ridge Farm #3	Talbot	none	absent
Holly Farm	Talbot	none	absent
Idylwilde WMA	Car.	none	absent
Issac Nave Farm #1	Talbot	none	unconfirmed rep.
Issac Nave Farm #2	Talbot	none	unconfirmed rep.
Issac Nave Farm #3	Talbot	none	unconfirmed rep.
Kellogg Farm #3	Talbot	none	absent
Linkwood WMA	Dor.	none	present
Martinak State Park	Car.	none	absent
Millington WMA	Kent	none	absent
Moore's Farm	Talbot	none	absent
Poplar Swamp	Car.	some cutting	absent
Remington Farms	Kent	gypsy moth damage	release site

It was encouraging to find that no local Delmarva fox squirrel population was extirpated due to development or timber harvesting. Taylor (1973) postulated that the primary reason for this squirrel's decline was lumbering. On three of our study sites limited timber harvesting had occurred, but sufficient habitat was retained and the fox squirrels remained resident. This suggests that limited forestry operations are possible without extirpating the Delmarva fox squirrel. Obviously, if the entire tract of forest supporting a local fox squirrel population is timbered, the squirrels will be extirpated. However, if an appropriate portion of the forest is left uncut, fox squirrels can persist.

Perhaps few of the fox squirrel present sites were lumbered because many of the sites were owned by those who did not need the revenues from a timber sale. Secondly, the presence of an endangered species does impose some restrictions on habitat alteration, although it does not necessarily exclude it. Many of the landowners were proud to have the fox squirrel residing on their property and may have forgone habitat alterations because of their concerns for the squirrel. Also, nine sites were in public ownership.

Increased development may be the next major threat to Delmarva fox squirrel habitat. However, provided that appropriate habitat is allowed to remain, low density residential development may be tolerated by these squirrels, as is evidenced by four fox squirrel present sites where some development occurred nearby.

The estimated colonization rate is probably an underestimate of the true colonization rate. A number of the fox squirrel absent sites were considerable distances from known Delmarva fox squirrel populations, thus there was no source of squirrels for colonization. The Linkwood WMA site, which was colonized, was on the periphery of the squirrel's occupied range. Using only those sites near natural populations, the annual colonization rate increased to 0.004. This rate is double the estimated extinction rate.

The Maryland Department of Natural Resources is accelerating colonization by live trapping Delmarva fox squirrels from stable populations and releasing them in appropriate habitat within the historic range. To date, 10 releases have been made in Maryland. Remington Farms was one such site. However, the squirrels did not remain on Remington Farms, but relocated to another site approximately 3 km away and established a population there.

It should be noted that the sites listed in this paper as having fox squirrels now are not the only locations for Delmarva fox squirrels in Maryland. These sites represent approximately 30% of known Delmarva fox squirrel populations. Taylor's (1976) 36 fox squirrel present sites represented about 60% of the population known then.

We are optimistic about the future of the Delmarva fox squirrel. Cooperation from landowners, the timber industry, developers, local planning and zoning agencies, and others can help to insure the continued existence and, hopefully, the recovery of this endangered species.

Acknowledgements

Special thanks are extended to the landowners and others who provided information on the status of local sites. The Delmarva Fox Squirrel Recovery Team encouraged initiation of the project. This effort was funded in part by Section 6 Endangered Species Funds from the U.S. Fish & Wildlife Service's Region 5 Office. R.D. Dueser and G.J. Taylor reviewed the original draft of the manuscript and provided valuable comments.

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Reviewers For Volume 32

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Dr. David Bohaska	Dr. Larry Morse
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Mr. Haven Kolb	Dr. Donald Windler
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Mr. Daniel Morrow	Dr. Howard Erickson

Mailing Dates For Volume 32

Volume 32 was published as two double numbers, Number 1-2 was mailed in June of 1988 and Number 3-4 was mailed in April 1990. The editor apologizes to all subscribers for the late appearance of these issues and would like to assure you that every effort is being made to do better in the future.

The Maryland Naturalist is a quarterly publication of the Natural History Society of Maryland. Subject matter includes all areas of the natural history of Maryland and adjacent states. Suitability of manuscripts will be determined by the editor. All accepted manuscripts will be reviewed by appropriate specialists prior to publication. Address all manuscripts and correspondence to Editor, *The Maryland Naturalist*, Natural History Society of Maryland, 2643 North Charles Street, Baltimore, Maryland 21218.

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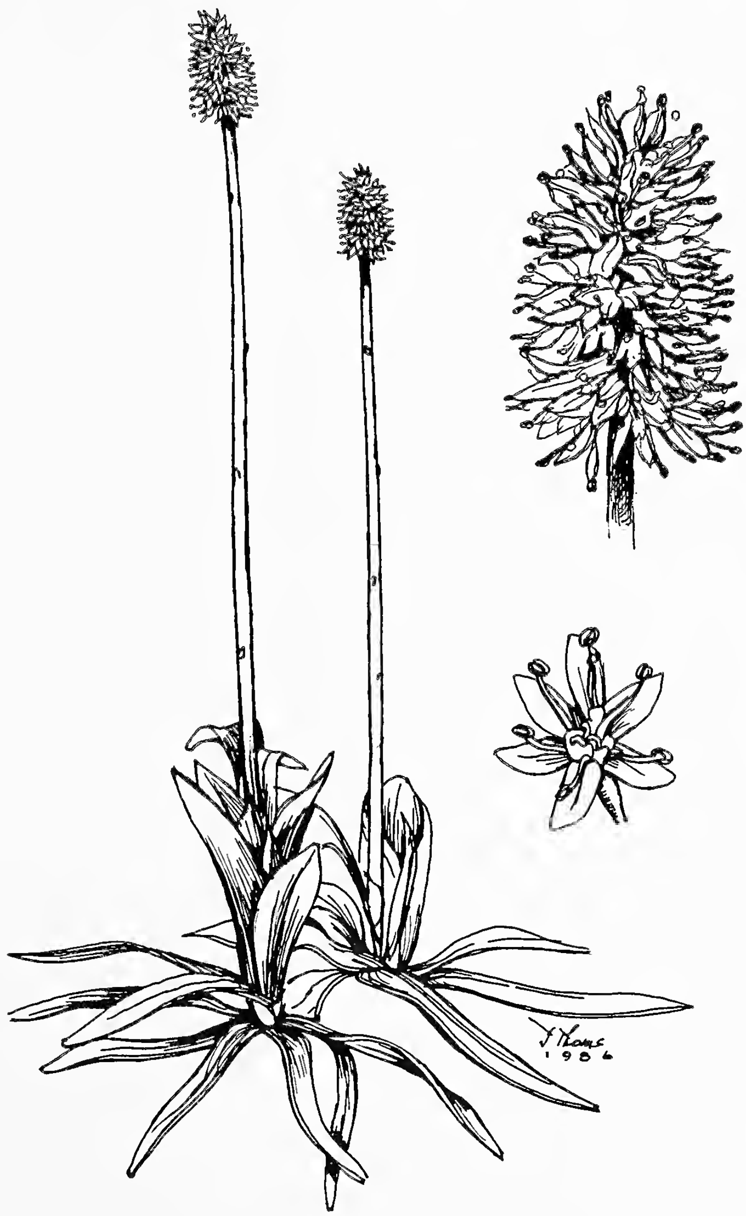

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Arnold W. Norden, Editor

Mailing Date: October 20, 1990

Cover Illustration: The Swamp-pink (*Helonias bullata*), a rare bog dwelling lily, is presently known in Maryland from only five sites. It is listed as Endangered by the Maryland Department of Natural Resources, and as Threatened by the U.S. Fish and Wildlife Service. This is an original drawing by Josephine B. Thoms.

Maryland's Oldest Residents: Archeological Investigations at the Higgins Site

Carol A. Ebright

Introduction

Approximately 12,000 years ago, some of the first residents of Maryland occupied a small campsite along Stony Run in northern Anne Arundel County (Figure 1). Prehistoric Native Americans would continue to re-use the same site for the next 9000 years, each time leaving behind their broken and discarded tools, fireplaces, garbage, and debris from the manufacture of new stone tools. The remains of each occupation gradually became buried under as much as a meter of sediment, not to re-appear again until the same site was settled and farmed by Euro-American settlers in the 18th and 19th centuries.

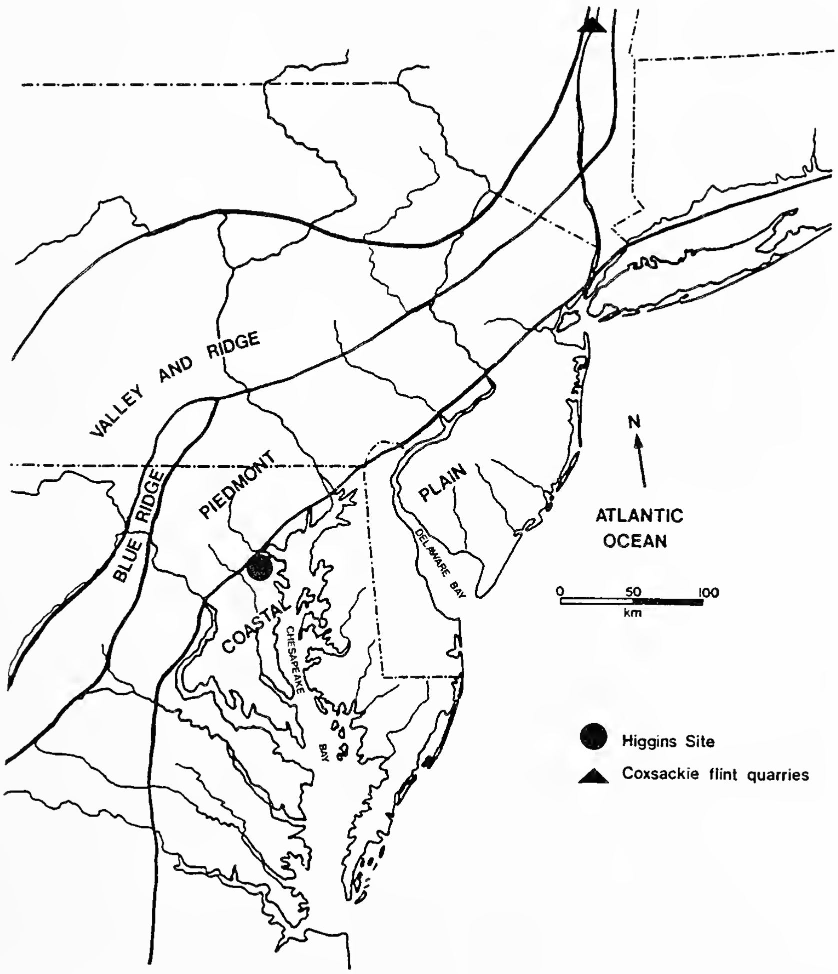


Figure 1. The location of the Higgins site in the Middle Atlantic Coastal Plain. The Coxsackie flint quarries, probable source of some of the Paleoindian lithic material, are located in the Hudson Valley in New York.

The prehistoric site was rediscovered around the turn of the century by Talbot Dickson Jones, an avid artifact collector from Baltimore who kept excellent records on the provenance of his finds. Artifacts in Mr. Jones' collection from the plowed fields around Stony Run indicated an extensive Indian occupation of the area between 3000 and 5000 years ago.

By the 1940s, the farmed area was reverting to woodland, but the prehistoric site was still occasionally visited by other collectors. One of these, Edward Higgins, also amassed a collection of artifacts from a more restricted area, now formally known as the Higgins site and designated by state site number 18AN489. Projectile points collected by Mr. Higgins provide still more evidence of extensive use of the site by American Indians over 3000 years ago (Figure 2). Richard Stearns, who recorded several sites in the vicinity of the Higgins site (Stearns 1949), did not collect from this location probably due to extensive overgrowth.

The Higgins site first came under professional investigation in 1978 when this area of the county began to be developed as an air and rail transportation hub. At this time, limited subsurface testing indicated that extensive buried deposits could be present under the disturbed plowzone (Curry 1978). Because the site was thought to be potentially significant, efforts were made to avoid damaging the site, and the secrets of the Indian occupation remained sealed.

In 1987 a new threat of destruction emerged. This time development could not be avoided, and once more the site came under professional investigation. Between November 1987 and November 1988 the site was subjected to both systematic testing and large-scale excavations by the Division of Archeology of the Maryland Geological Survey. The excavations revealed considerable intact remains from time periods represented by the private surface collections, and also yielded evidence of the first intact occupation of the oldest Native Americans in Maryland, over 10,000 years ago.

Maryland Prehistory

Prehistory in Maryland is divided into three major periods: the Paleoindian, Archaic, and Woodland. The Paleoindian period includes the first occupation of the continent by immigrants from Asia who became the progenitors of American Indians. Some archeologists now place the date of the initial migrations as early as 40,000 years ago.

Colonization of the Americas and survival during the Paleoindian period is intimately tied into the climatic and geological changes which occurred during the Pleistocene. While the continental ice sheet blocked much of the area between the interior Alaskan side of the Bering land bridge and the ice-free lower continent, southward passage may have been gained through an ice-free corridor which occasionally opened up between the east-central Keewatin and far western Cordilleran ice centers.

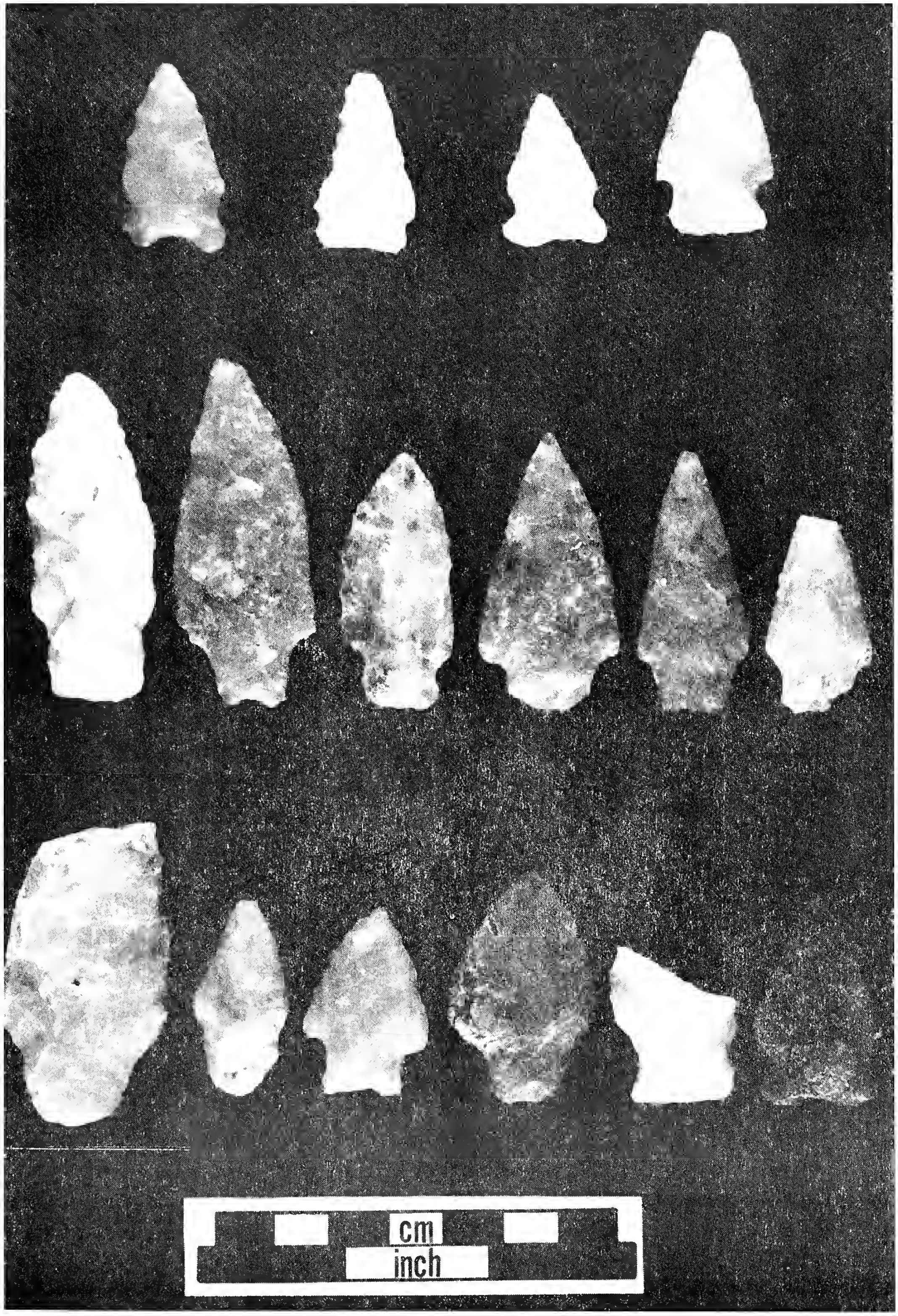


Figure 2. Projectile points from the Edward Higgins surface collection.

Alternatively, these earliest Americans may have traveled along the exposed western continental shelves.

The lowering of sea level and exposure of continental shelves also had its impact in the Chesapeake area. During the Pleistocene no Chesapeake Bay existed. TheSusquehanna River flowed much more swiftly to its Atlantic Ocean mouth near Norfolk, Virginia. Much of the eastern continental shelves were exposed as well.

Geomorphological changes in interior ice-free areas also occurred as a result of the continental glaciation. Although the Higgins site is now located in an "upland" setting in the Maryland Coastal Plain, about 15 meters above Stony Run, during the Paleoindian period the site was at streamside and subject to alluvial deposition.

Shortly after 10,000 B.C. indisputable remains attributable to Paleoindians are found over much of the Great Plains. These are closely tied to the exploitation of large Pleistocene megafauna such as mammoth, mastodon, and giant bison. Artifacts found with these animals include distinctive well-made spear points which had been fluted by the removal of one or more large, linear flakes from center of each face. Clovis and subsequent Folsom styles of fluted points have been defined.

Clovis fluted points and several regional variants are also found in the eastern United States, but lack the clear association with extinct Pleistocene game animals. Most numerous in the Southeast, the majority of fluted points are isolated surface finds. Several intact Paleoindian sites excavated in the far Northeast have yielded limited evidence of the hunting of migratory caribou. Excavated sites also established that eastern Paleoindians exploited a wide variety of both plant and animal resources, including small game and riverine species. The Paleoindian nomadic lifestyle appears to have included regular stops at major high quality lithic source areas, often hundreds of miles distant from the point of eventual stone tool discard.

As the Pleistocene ice sheets retreated, the Mid-Atlantic coastal plain underwent slow, but radical changes. Beginning about 8000 B.C., Archaic period Indians were witness to the gradual drowning of the exposed continental shelves, the inundation of the lower reaches of the Susquehanna River and, ultimately, the formation of the Chesapeake Bay. The filling of this estuary to present levels was nearly complete by the end of the Archaic period approximately 3000 years ago.

In the interior, water flow in streams such as Stony Run was probably slowed as the mouths of the Susquehanna and its tributary, the Patapsco River, were progressively drowned. Downcutting through the unconsolidated Coastal Plain sand and gravels, however, occurred rapidly and probably accelerated in late Archaic times.

Archaic Indians continued a hunting and gathering lifestyle that focused on smaller territories and involved distinct seasonal rounds. Hunters made extensive use of the atlatl or spear thrower. Exploitation of a wide variety of localized resources appears to increase through time, even though the nearby materials may be inferior in quality to

those obtainable at greater distances. This trend is particularly apparent in the selection of lower quality lithic materials for stone tool manufacture from local secondary deposits, rather than higher quality stone from more distant primary outcrops. Many Archaic sites appear to be situated to take advantage of the widest possible range of floral, faunal, lithic, and other resources simultaneously. The development of a new technology for creating stone tools by pecking and grinding may have expanded the use of plant resources for both food and tools. Based on changes in projectile point styles, material preferences, and other technological differences, the Archaic period is divided into three sub-periods: Early, Middle, and Late.

The gradual development of the Chesapeake Bay estuary created an entirely new set of floral and faunal resources, including wild grains, waterfowl, shellfish, and many fish species. By the end of Archaic period, these resources were well-enough established ecologically to be regularly incorporated into Native American subsistence patterns.

Intensive exploitation of the estuarine resources is manifested in numerous shell midden sites along the Bay, and coincides with the beginning of the Woodland period at about 1000 B.C. This period is also defined by the invention of ceramics, and domestication of plants. While horticulture would not become a primary means of subsistence in this area until very late in Woodland times, experimentation in new foodstuffs, new technologies, and new social organizations was clearly on the rise. The bow and arrow was also adopted during this time.

Woodland period prehistoric sites reflect increased diversity, with larger, more permanent settlements accompanied by small, functionally specific, temporary sites. This pattern becomes accentuated through time. Like the Archaic, the Woodland period is also divided into Early, Middle, and Late subperiods.

During Woodland times, the downcutting of Stony Run reached a point where alluvial deposition was no longer a significant factor in site burial. By historic times the Higgins site was isolated on an "upland" ridgetop. Both aeolian and colluvial processes may have been active throughout the Woodland period in continuing the burial of archeological deposits.

Archeological Investigations at the Higgins Site

By the time of the 1987 archeological investigations at the Higgins site, the property had been surficially disturbed in several ways. The site had been cleared, farmed through the 1930s, reverted to woodland over the succeeding decades, and been subjected to a forest fire in the 1960s. Shallow surface ditches incised the ridgetop, and a dirt fire-road bisected the property.

Fieldwork at the Higgins site proceeded in two stages: systematic testing, followed by large scale excavations. Although the general site location had been known since the turn of century, the testing program was essential to determine the horizontal site

boundaries, the depth of deposits, the degree to which the subplowzone deposits were intact, and the range of archeological components present.

These goals were accomplished by the excavation of 176 circular shovel test pits, 50 cm in diameter and dug to sterile soil. All shovel tests were at least 50 cm deep. The pits were located every 15 meters on a grid system which covered the entire remaining intact ridgetop.

In order to determine which artifacts were in intact subsoil, the shovel tests were excavated stratigraphically. The distribution of artifacts from the tests was plotted to provide more information about the internal structure of the site. The prehistoric artifact distribution from the upper disturbed levels was quite different than that from the intact subsoil (Figure 3). Highest densities of prehistoric artifacts from the plowzoneoccurred at the southern extremity of the site. Artifacts from the intact subsoil, however, were concentrated in the north central site area. Plowing had also "homogenized" the artifact distribution. Upper layer artifacts had a continuous distribution over the site, with some areas of higher density. In contrast, artifacts from below the plowzone were clustered in a number of discrete areas, often surrounded by relatively sterile zones.

Historic artifacts recovered from shovel tests and other excavations at the Higgins site span a broad time period. Most were quite small, and included domestic ceramics and vessel glass, brick fragments, coal, slag, cinders, oyster shell and miscellaneous metal items. Architectural debris was rare, widely scattered, and extremely fragmented, suggesting that no permanent structure was ever located on the site. Coal, slag, cinders, shell and domestic debris were so widely dispersed and unrelated to each other that it would appear that these artifacts were probably incorporated into fertilizer (possibly manure collected from Baltimore city streets), and thus transported onto the site (Esther C. White, Higgins site historic analyst, personal communication).

It is clear from the prehistoric artifacts recovered from shovel tests that nearly all the Indian occupants of the site made extensive use of local quartz cobbles for tool manufacture. Quartz debitage makes up about 86% of the entire assemblage from shovel tests. Occasional flakes of rhyolite (3%) were also recovered, along with 7 chert flakes (0.3%). Projectile point types recovered from shovel tests included a variety of Archaic period types, many similar to those found in the Jones and Higgins collections. Two points from the subsoil, however, provided evidence of Early and Middle Archaic occupations. No prehistoric ceramics were uncovered, indicating little use of the site during the Woodland period.

Also during the testing phase, 24 square meters of test excavations were opened in seven small units to further evaluate site stratigraphy. Shovel testing had shown the subsoil over most of the site to consist of leached sand or silty sand with no visible layering that might correspond to separate archeological occupations. In most parts of the site, this soil was yellowish brown (Munsell color 10YR5/4-8) to strong brown (7.5YR4-5/6-8), however, widely scattered shovel tests had bright yellowish red

(5YR4-5/6-8) to red subsoil (2.5YR5/6-8). Some widely dispersed shovel tests also contained large pieces of limonite. Test units were placed to evaluate these soil anomalies, as well as to search for evidence of stratification, and intact features or living floors in areas of high artifact density.

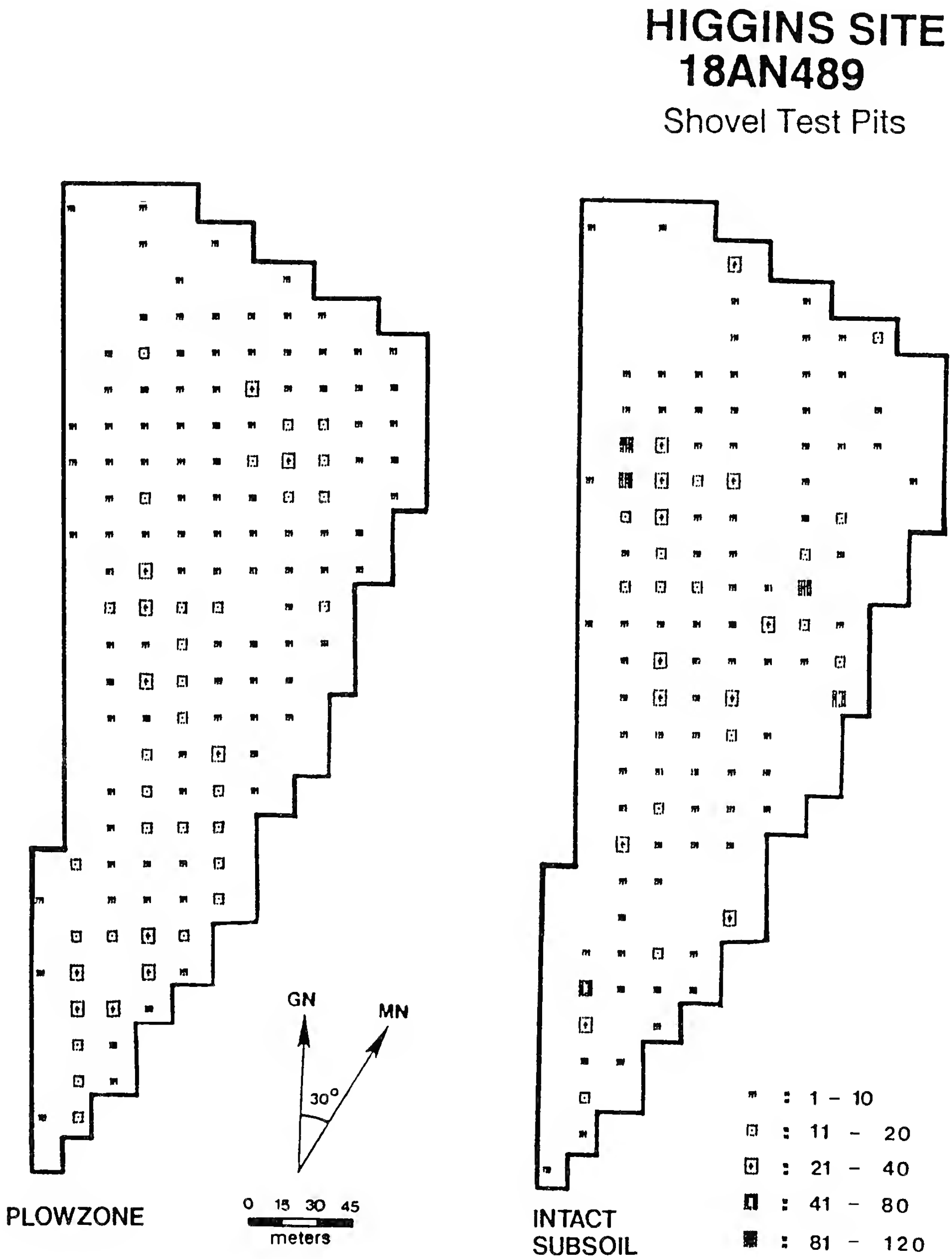


Figure 3. Relative densities of prehistoric artifacts from shovel test pits in plowzone vs. intact subsoil contexts.

Excavation techniques consisted of using thin 5 cm arbitrary levels in subplowzone deposits in order to detect any potential vertical stratification. When possible, all artifacts, including rocks and large flakes were pedestalled and mapped in place. In two test units, 5 and 6, however, nearly all the prehistoric cultural material was found in the plowzone.

Only one of the test units, Unit 7, showed evidence of potential stratification. In this case, one set of fire-cracked rock was found several levels above another fire-cracked rock scatter, however, no diagnostic artifacts were present. Because the artifact distribution also shows a steady decrease with depth, this instance of "stratification" is somewhat ambiguous.

While test units showed little evidence of vertical stratification, the test excavations did indicate horizontal separation of components of different time periods. Test Unit 3 (4 sq m), located near a shovel test pit with a particularly high density of debitage, yielded a Middle Archaic rhyolite Otter Creek point in association with a small hearth feature (Figure 4). A scattering of fire-cracked rock and concentration of debitage marked other portions of this living area.

Test Unit 2 (6 sq m) contained an Early Archaic component characterized by bifurcated-base points as well as a yet undefined component typified by broad side-notched projectile points. The excavation also contained four features consisting of small clusters of fire-cracked rock about 20 to 30 cm in diameter. These are thought to represent either hearth areas, or places where boiling stones may have been discarded. Underlying the features was a massive concentration of large pieces of limonite, embedded in red subsoil (Figure 5). At the time of testing, the configuration appeared to suggest human placement of the limonite in semi-circle, possibly as part of a shelter.

Test Unit 6 (2 sq m) yielded two extremely well-made quartz Bare Island projectile points, and one indication that the reddish subsoil could be a natural occurrence. A burned stump remnant surrounded by increasingly red soil towards the burn area was found in this excavation.

Evidence of another living floor was exposed in Test Unit 1, (4 sq m), also located near a shovel test with a high density of artifacts. Although no discrete features were found, a scattering of fire-cracked rock and stone tools was uncovered. One of these artifacts was a broken pecked and ground axe with a worn full-groove manufactured from amphibolite. Two quartz stemmed points of uncertain typology were also recovered.

Despite the presence of intact features and living floors, several characteristics of the site defined during testing would make future interpretations difficult. The highly permeable and leached sands contained virtually no organic material such as bone or carbonized floral remains, severely limiting the prospects for absolute dating of any of the components found on the site. These soil characteristics also resulted in the impossibility of identifying cultural features by differences in soil color or texture relative

Figure 4. Small fire-cracked rock cluster found in Test Unit 3 with associated Otter Creek projectile point.

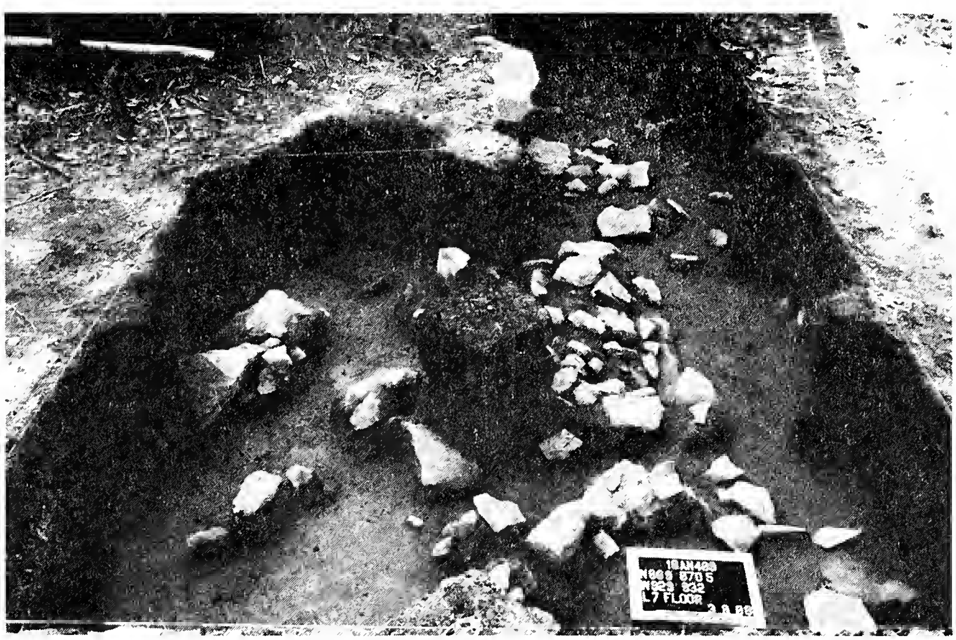


Figure 5. Limonite concentration exposed in Level 7 of Test Unit 2.

to the surrounding matrix. Features and living areas had to be defined solely on the basis of artifact groupings.

At the same time, the Higgins site presented an almost unparalleled opportunity to study the organization of several potentially discrete, intact, Archaic period occupations. The vast majority of known Archaic period sites in Maryland consist of upland and hilltop scatters with artifacts of many time periods contained wholly in the plowzone. Few intact Archaic period sites from Maryland have ever been excavated. The deep burial on a ridgetop of relatively recent geological origin also provided an opportunity for collaboration with specialists in archeology, pedology, geomorphology, and palynology in reconstructing both the paleoenvironment and the process of archeological site formation and burial.

The presence of multiple Archaic period components also allows the study of differential use of resources, particularly lithic resources, through time. Definition of manufacturing, tool use, and curation and discard strategies were particular problems to be addressed in large scale excavations.

Full-scale excavations at the Higgins site concentrated on the portion of the property facing immediate destruction. Although 135 sq m of excavations were planned, the exceptionally dry summer and fall of 1988 provided nearly ideal excavating conditions and allowed us to complete a total of 221 sq m. The excavation area was organized into three large blocks, Blocks 1, 2, and 3, with the intent of uncovering as much contiguous area as possible (Figure 6). While excavation of these blocks may not fully represent the range of activities undertaken on the site, it permitted a more complete exposure of living areas related to specific prehistoric occupations.

The largest contiguous excavation, Block 1, consisted of 151 sq m initiated in areas of moderate to high artifact density in nearby shovel test pits. Block 2 expanded Test Unit 2 in an effort to recover more information on the earliest Archaic component, and to attempt to define the origin and function of the concentration of limonite slabs. Eighteen additional square meters were excavated in this area. Block 3 focused on the area surrounding Test Unit 3, an apparent Middle Archaic occupation area. It eventually encompassed 56 sq m, including the test unit location.

Excavation strategy differed slightly during these larger investigations as a consequence of test excavation findings. The apparent lack of vertical stratification led us to use a thicker 10 cm arbitrary level in subsoil excavations. The large number of small flakes recovered in the screens during test excavations indicated a severe bias would be introduced if only the larger easily visible debitage was individually mapped. During block excavations, therefore, artifact provenance was maintained in 50 cm quadrants to give tighter spatial control but still account for artifacts of all sizes. Tools, larger artifacts, and fire-cracked rock, however, continued to be individually mapped.

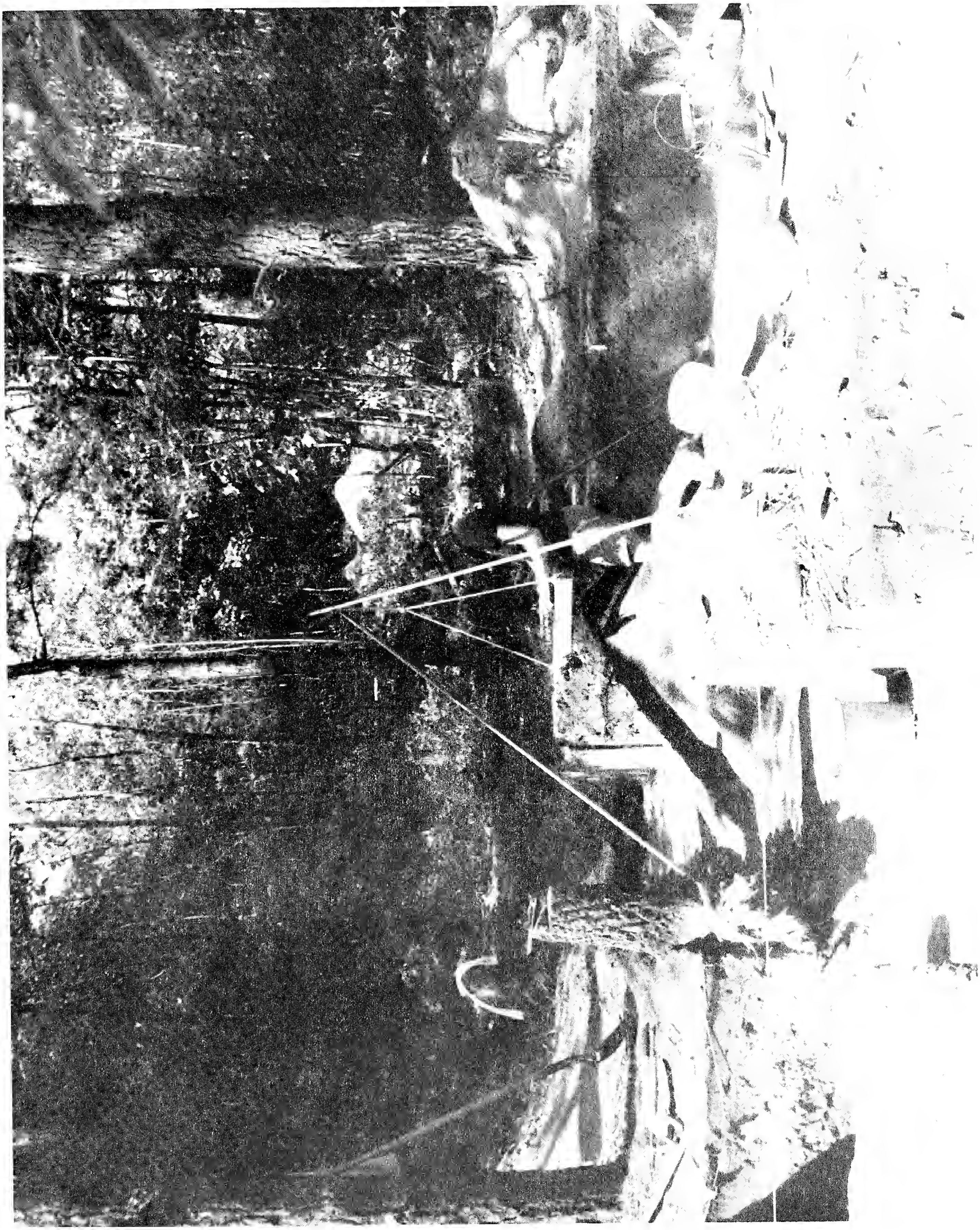


Figure 6. Block excavations at the Higgins site.

As during the test excavations, two-gallon soil samples were collected from the southwest quadrant of each sub-plowzone level in each 1 x 1 m square. These would subsequently be processed by water flotation to recover both small organic remains as well as a systematic sample of small debitage that would normally pass through a 1/4 inch screen.

One excavation unit in each block was excavated to depths well below the cultural-bearing levels in order to assess the soil profile, the geological history of the landform, and the processes by which the site was buried. Columns of soil samples were collected from each block for grain size and shape analysis, geochemical analysis, and mineralogical content. Soil analyses would be used to determine the sediment sources as well as the processes of transport to the site.

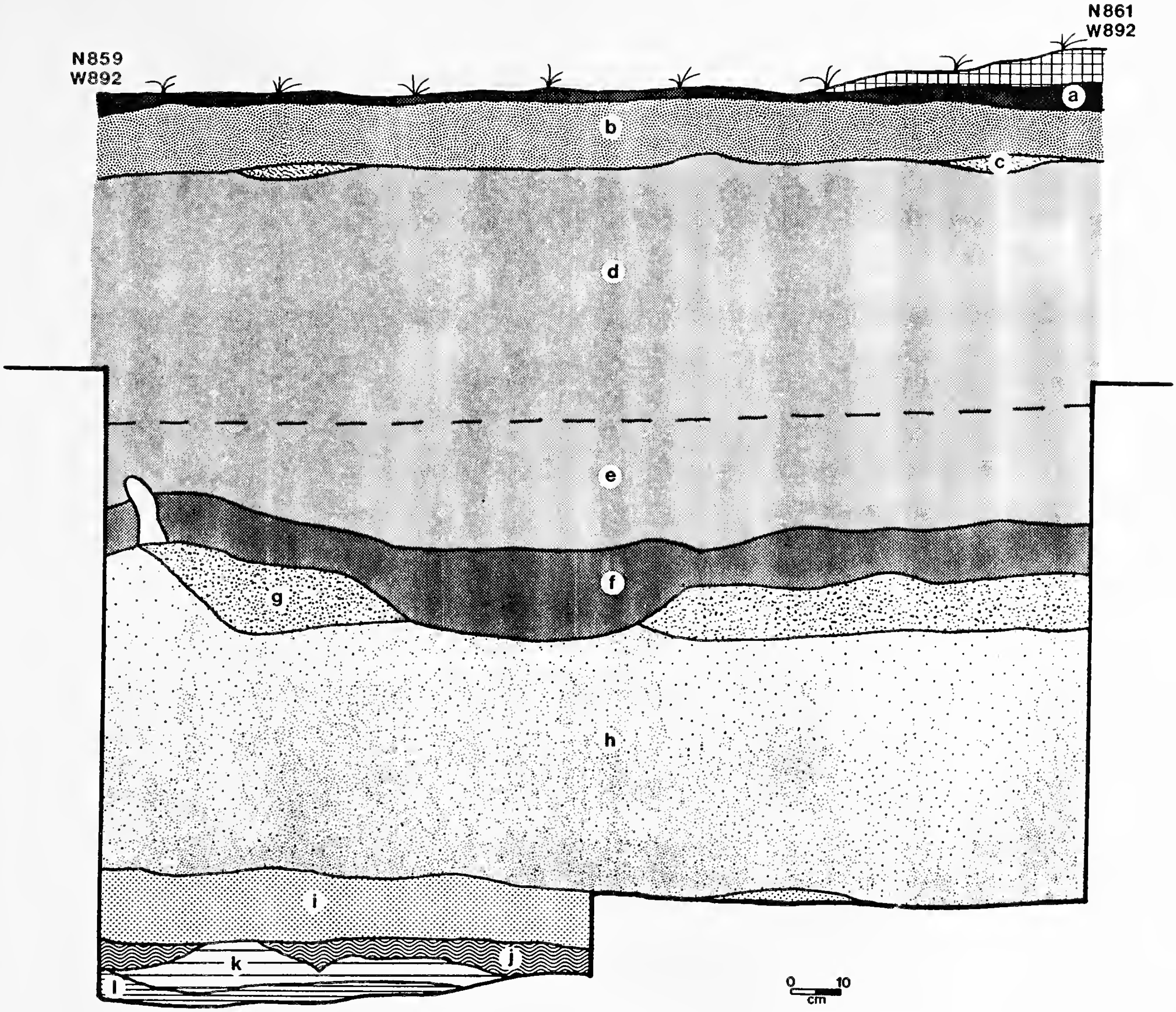
Soil sample columns were also collected from the deep units for pollen analysis and were used to obtain paleo-environmental information during the period of human occupancy. Additional soil was collected from the pedestals underneath tools and from within features, and analyzed for both pollen and other micro-residues such as phytoliths, and organic fibers that might provide clues to specific tool and feature functions.

Numerous temporally diagnostic artifacts and other tools collected from intact subsoil were not washed in order to test them for blood, pollen, fibers, and other micro-organic residues that would allow more accurate inferences about their use, and about general subsistence patterns. All pollen, phytolith and micro-residue data reported herein is taken from Seward (n.d.).

Despite the relatively level terrain in the site area and the proximity of the block excavations to each other, the soil profiles in the three units showed remarkable differences. Block 1 contained a meter-thick sand horizon not present in the other two blocks (Figure 7). The deep unit in Block 2 exposed a thick, brilliant red, hematite-rich compact soil horizon beneath the limonite slabs. One face showed evidence of an episode of fluvial incision (Figure 8). Block 3 also contained a very thin layer of reddish soil containing small pieces of limonite. Underlying this was an extensive deposit of gray and white marbled Cretaceous clay not exposed elsewhere on the site (Figure 9).

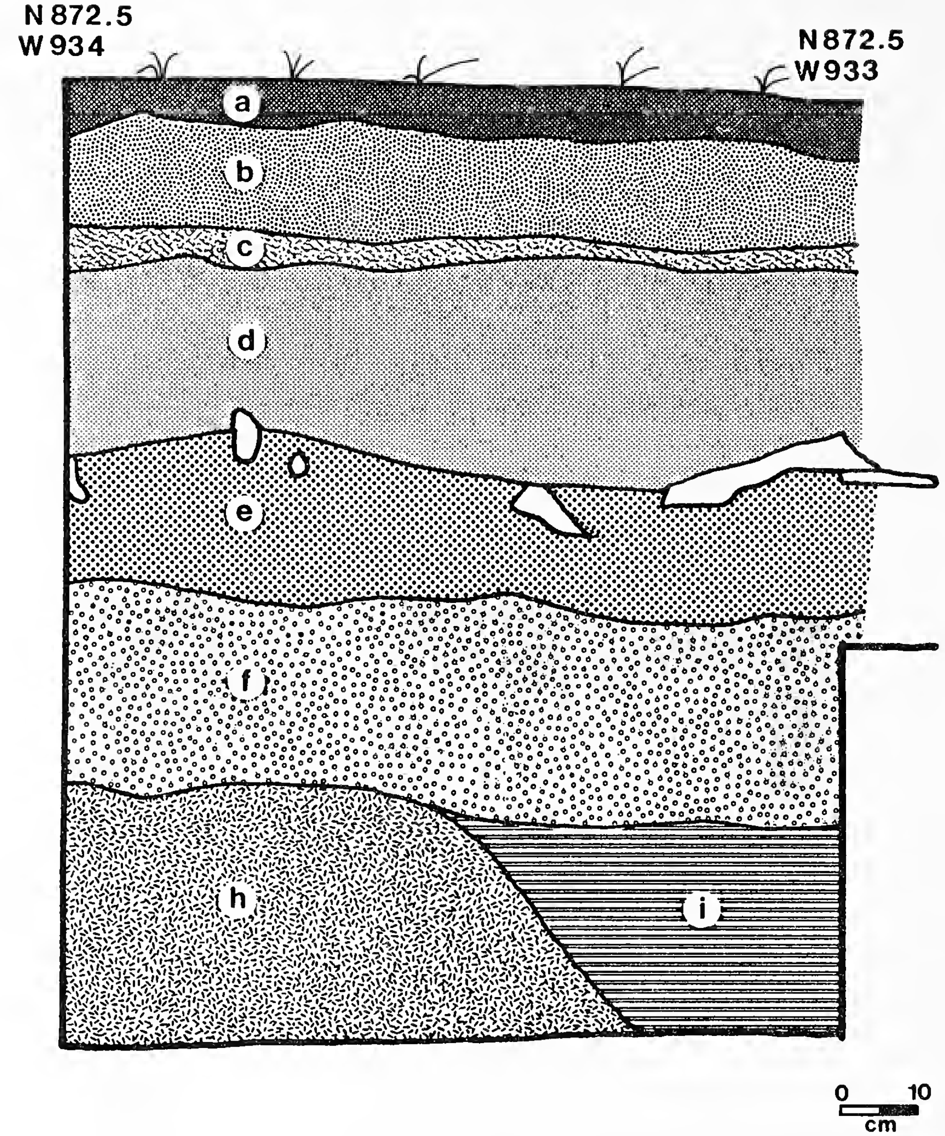
These differences suggest that the present topography may not be an accurate reflection of the past landscape, even during geologically recent prehistoric times. Excavations in both Blocks 1 and 3, in fact, produced evidence of buried stream channels in the culture-bearing levels. Decades of plowing may have eradicated some of the microtopographic relief. Other depositional processes may simply have filled in areas of low relief.

Excavation of the three large blocks at the Higgins site produced some spectacular results. Several large Early, Middle, and Late Archaic living floor areas were exposed along with associated diagnostic artifacts, other tools, and features. Additionally, two new buried components from the Paleoindian and Early Woodland periods not identified during earlier work at the site were discovered.



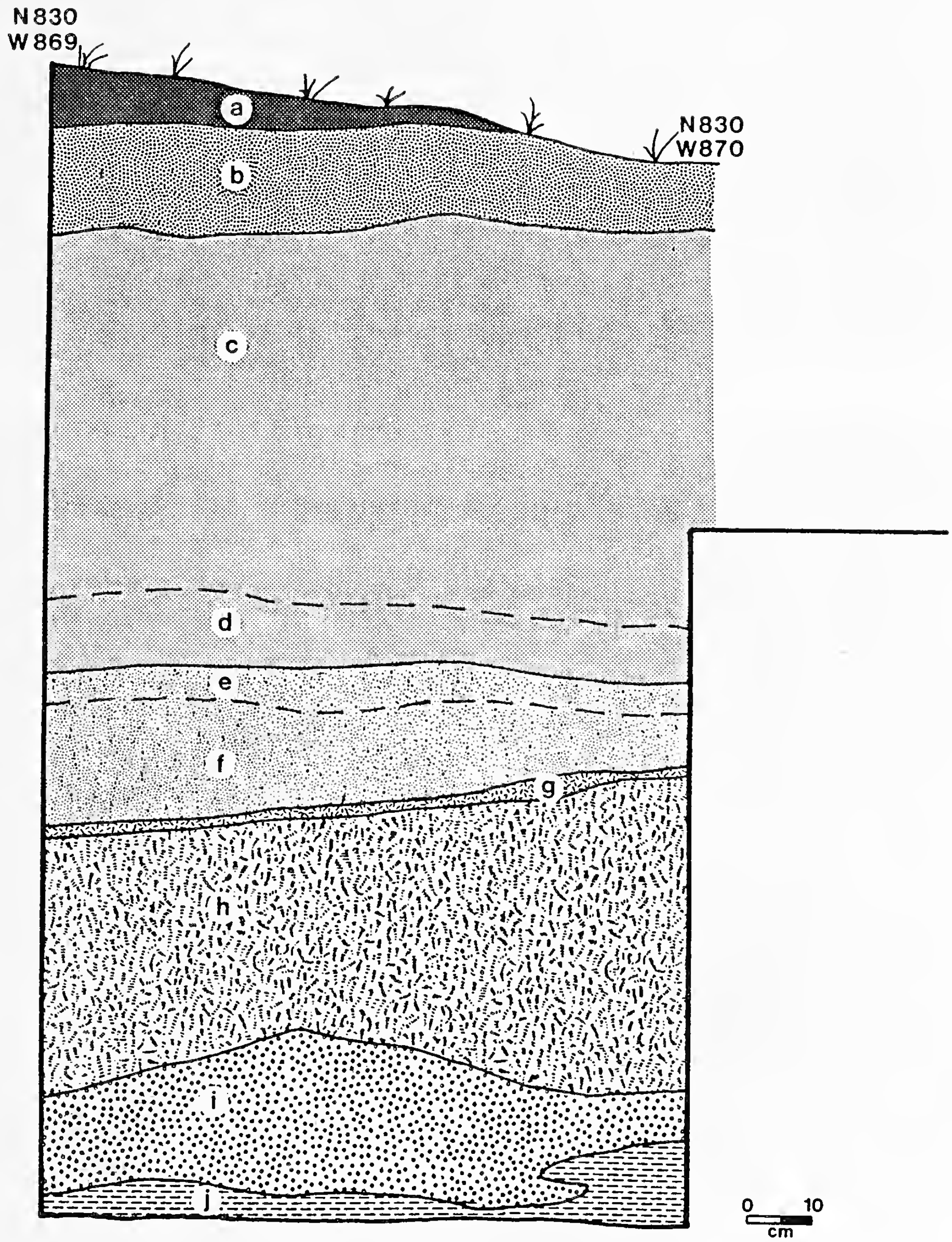
a humus, silt loam, 10YR3/3, clear, irregular boundary
b plowzone, sandy silty loam, 10YR3/3, abrupt, irregular boundary
c remnant plowzone, sandy silty loam, 10YR4/4, isolated pods
d silty sand, 7.5YR4/6, indistinct gradual transition
e compact silty sand, 7.5YR5/6, clear, irregular boundary
f 40% fine sand, 7.5YR7/6; mottled with 60% compact silty sand, 7.5YR5/6, irregular boundary
g friable fine sand, 7.5YR7/6, indistinct boundary
h 60% fine sand, 7.5YR6/6; mottled with 20% coarse sand, 7.5YR5/8, and 20% fine sand, 7.5TR7/6, abrupt, even boundary
i compact silty sand, 5YR5/8, abrupt, even boundary
j 50% clayey sand, 5YR5/6; mottled with 50% sandy clay, 10YR7/4, abrupt, irregular boundary
k sandy clay, 2.5YR5/8, abrupt, even, sloping boundary
l clayey sand, 5YR5/6, lower boundary not determined

Figure 7. Profile of the deep unit excavation in Block 1.



a humus, sandy silty loam, 10YR2/1, clear, irregular boundary
b plowzone, silty sandy loam, 10YR3/3, abrupt, even boundary
c remnant plowzone, silty sandy loam, 10YR4/4, abrupt, irregular boundary
d silty sand, 7.5YR5/6, indistinct boundary
e silty sand, somewhat lighter than 7.5YR5/6, with 30-60% large limonite slabs, clear boundary
f slightly clayey silty sand, 5YR5/4, with 10-40% small hematite fragments, abrupt, wavy boundary
h extremely compact clayey silt, 10R4/8, with 40% hematite; abrupt, even sloping boundary in north wall, irregular boundary in west wall
i 50% extremely compact sandy silt, 5YR5/5; banded with 50% extremely compact sandy silt, 2.5YR5/5, lower boundary not determined

Figure 8. Profile of the deep unit excavation in Block 2.



a	humus, sandy silty loam, 10YR3/2, clear boundary
b	plowzone, silty sandy loam, 10YR3/3, abrupt, irregular boundary
c	silty sand, 7.5YR5/6, indistinct boundary
d	sand, 7.5YR5/6, with 10% small limonite fragments and quartz pebbles, clear boundary
e	sand, 7.5YR5/6, with 30% limonite and quartz pebbles, clear wavy boundary
f	sandy clay, 2.5YR4/8, with 50% hematite and quartz pebbles, abrupt, sloping boundary
g	sandy clay, 7.5YR6/6, abrupt, sloping boundary
h	60% clay, 5YR5/2, mottled with 30% silty clay, 10YR7/2, forming vertical linear streaks extending into the next layer; occasional large pieces of hematite; abrupt, peaked boundary
i	30% clayey silt, 7.5YR6/6; mottled with 30% clayey silty sand, with 40% hematite and quartz pebbles, abrupt, highly irregular boundary
j	clay, 7.5YR5/2, lower boundary not determined

Figure 9. Profile of the deep excavation in Block 3.

Early Woodland Component

A large concentration of fire-cracked rock and small pieces of limonite found just under the plowzone in Block 3 yielded the first pottery known from the site, and the first evidence of an intact Early Woodland occupation (Figure 10). Although only a limited number of pottery sherds were located, most could be reconstructed as part of a single vessel of the Marcey Creek type. This steatite-tempered ware is the earliest pottery known from the Middle Atlantic area, and vessels often take the form of earlier soapstone bowls.

Figure 10. Feature 13 contained fragments of a pottery vessel dating to the early Woodland period. Arrow points to a visible large sherd.

The Higgins site Marcey Creek vessel contains portions of the base, body and the rim, and also has a lug (Figure 11). Rim curvature indicates that the pot was round or oval with a diameter of 8 to 12 inches. The exterior base is irregular and may have been molded directly against the ground. Except for small crenellations on the rim, it is undecorated. The vessel in unusual in the thinness of the walls, the small size of the steatite temper, and the application of the lug. While most Marcey Creek vessels have squarish handles that were molded directly as part of the pot, this specimen has a lug which was fashioned separately, and then inserted into a hole poked through the side of the pot before firing.

Abnormally high quantities of sunflower, mulberry, and cherry pollen found on the broken sherds provide clues about the ingredients of the last food cooked in this vessel.

Unfortunately, the Early Woodland occupation was small, and few buried artifacts can be considered to be associated with the feature containing most of the ceramics. A single rhyolite Dry Brook Fishtail point found 4 meters to the west, probably relatesto this component. Although small quartz contracting stem Piscataway and Wading River points from this period are relatively common in disturbed upper layers, none occurred in the vicinity of the ceramic artifacts.

Late Archaic Component

The Late Archaic period occupation is marked primarily by the presence of stemmed, quartz Bare Island projectile points (Figure 12 a-d). Much of the Late Archaic focus seems to have been on tool manufacture from quartz cobbles obtained from the immediate site vicinity. Hammerstones, broken biface fragments, and quartz debitage are common. In general, there is little variety in the tool kit, however, there is also evidence that generalized tool types such as bifaces, hammerstones, and discarded cores were used in several functions. Several bifaces were recovered with evidence of polish on lateral edges and in concavities suggesting their use in scraping materials such as hides, wood, bone or antler. Some hammerstones and cores have areas of polish and/or striations and may have been used as smoothing or burnishing stones, perhaps in the manufacture of wooden artifacts such as mortars or bowls. Based on microscopic examination of pollen, two hammerstones show evidence of being used to process butternuts, beechnuts, and chestnuts.

Ground stone and use-modified artifacts that appear to be associated with this occupation include a large gneiss end-battered pestle (Figure 13 a), and a mano and metate found in close proximity to each other (Figures 14 a,c). Pollen data indicate that the mano was last used to grind acorns.

Late Archaic flintknappers were adept at turning quartz cobbles into bifaces and then projectile points. Cobbles were often split by a bipolar technique, and then

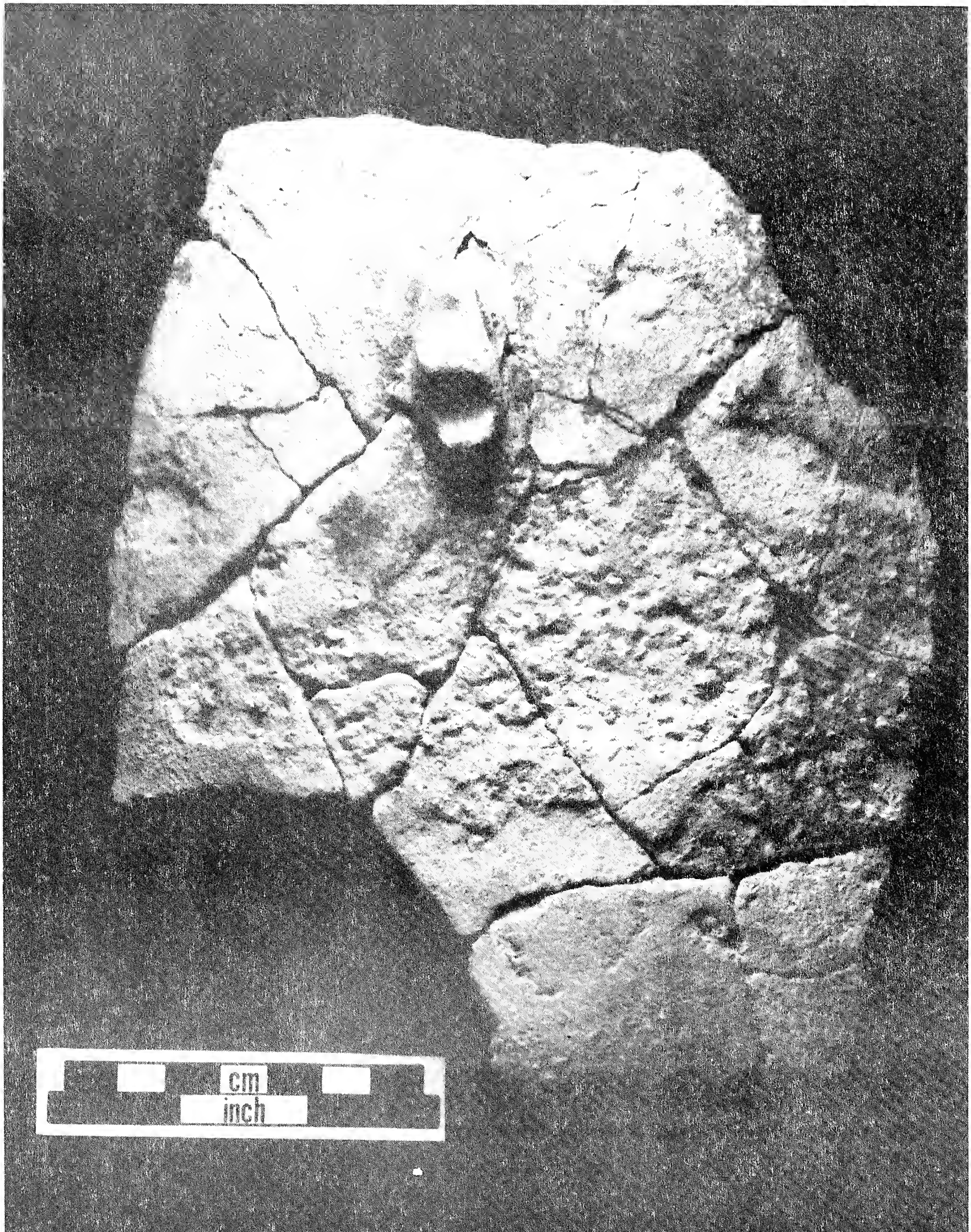


Figure 11. Reconstructed Marcey Creek vessel fragment showing crenellated rim, lug, and heel.

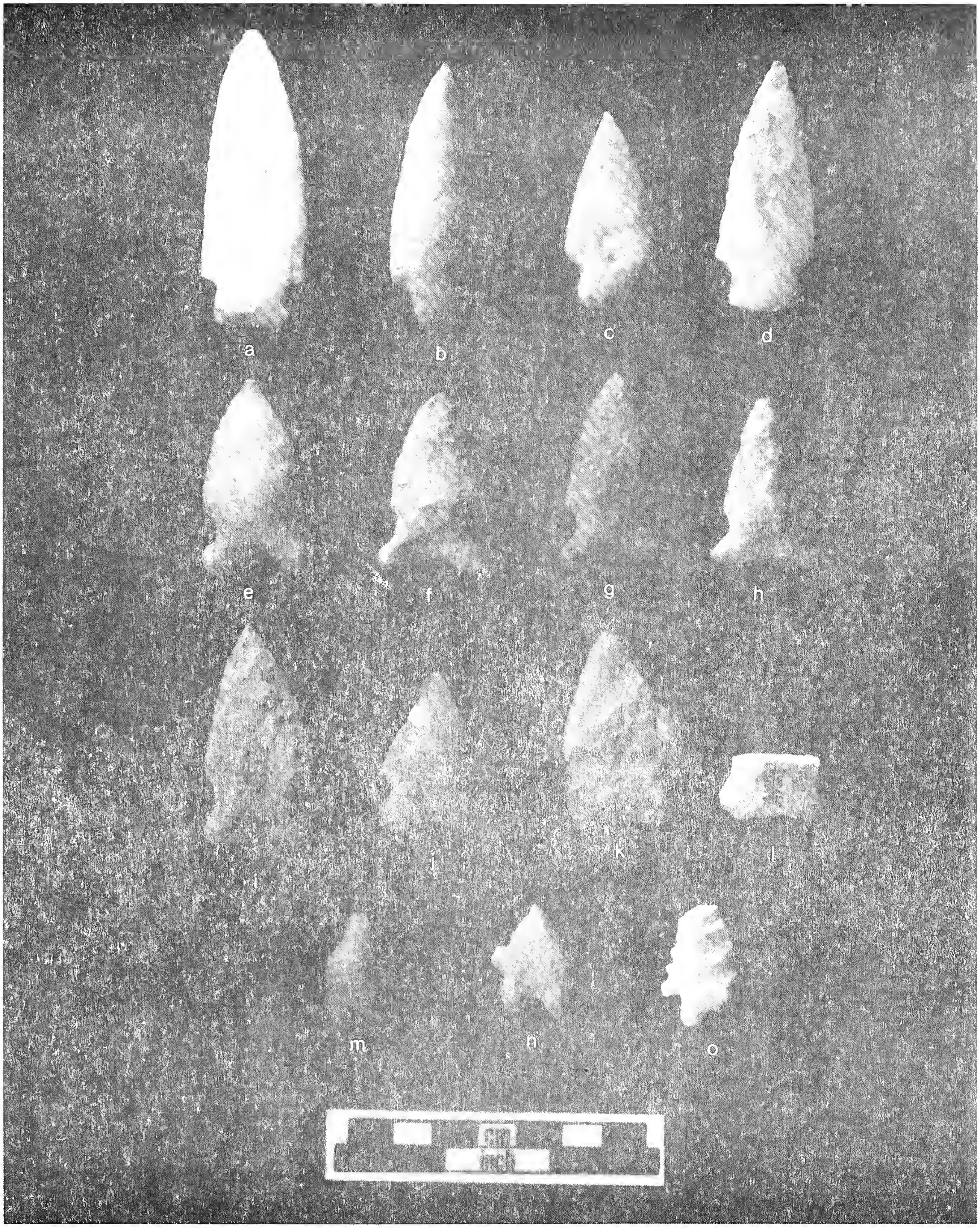


Figure 12. Selected Bare Island, Otter Creek, LeCroy and Untyped Side-notched points from the Higgins site.

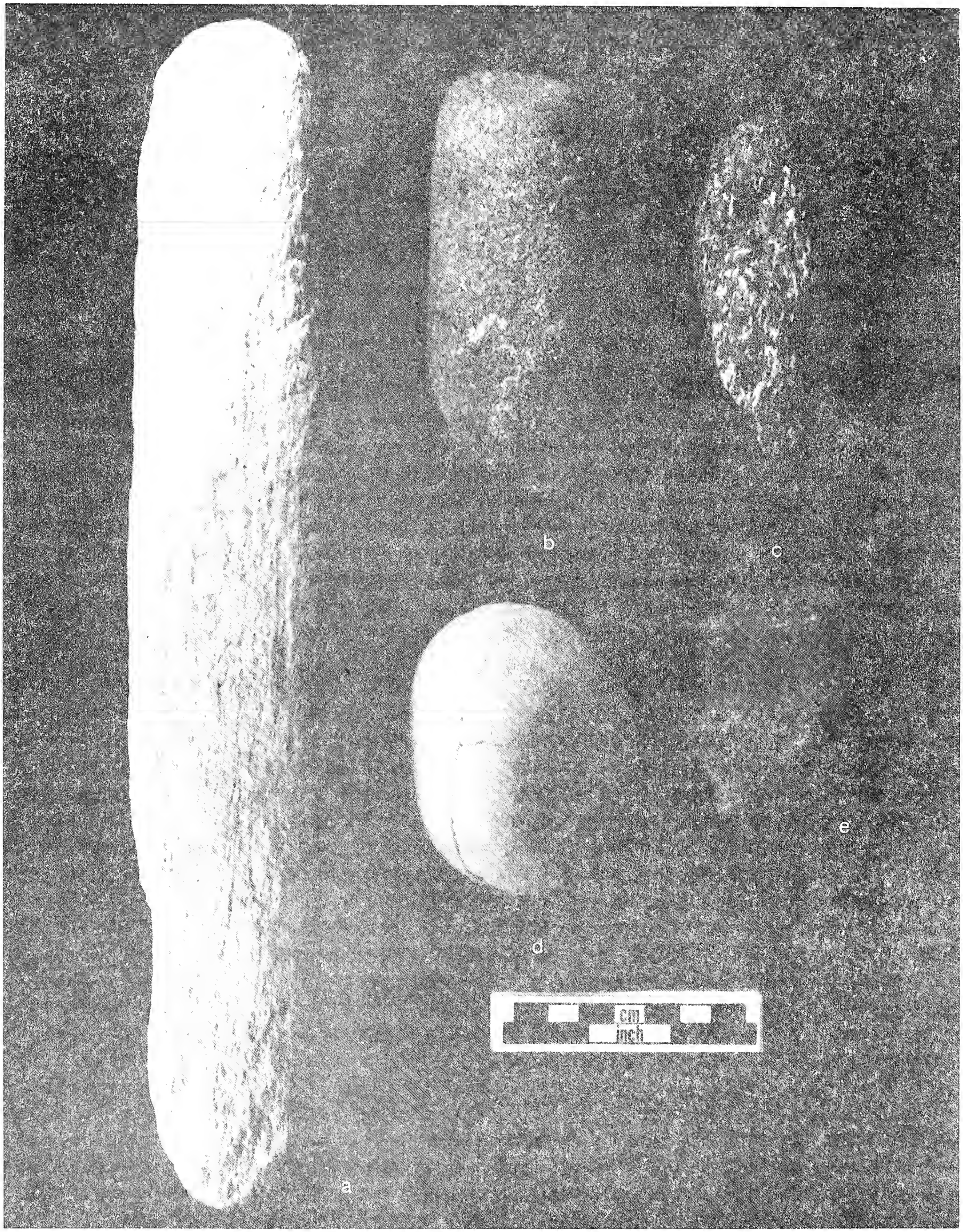


Figure 13. Pestles, a hammerstone with burnishing marks and a grooved axe fragment from the Higgins site.

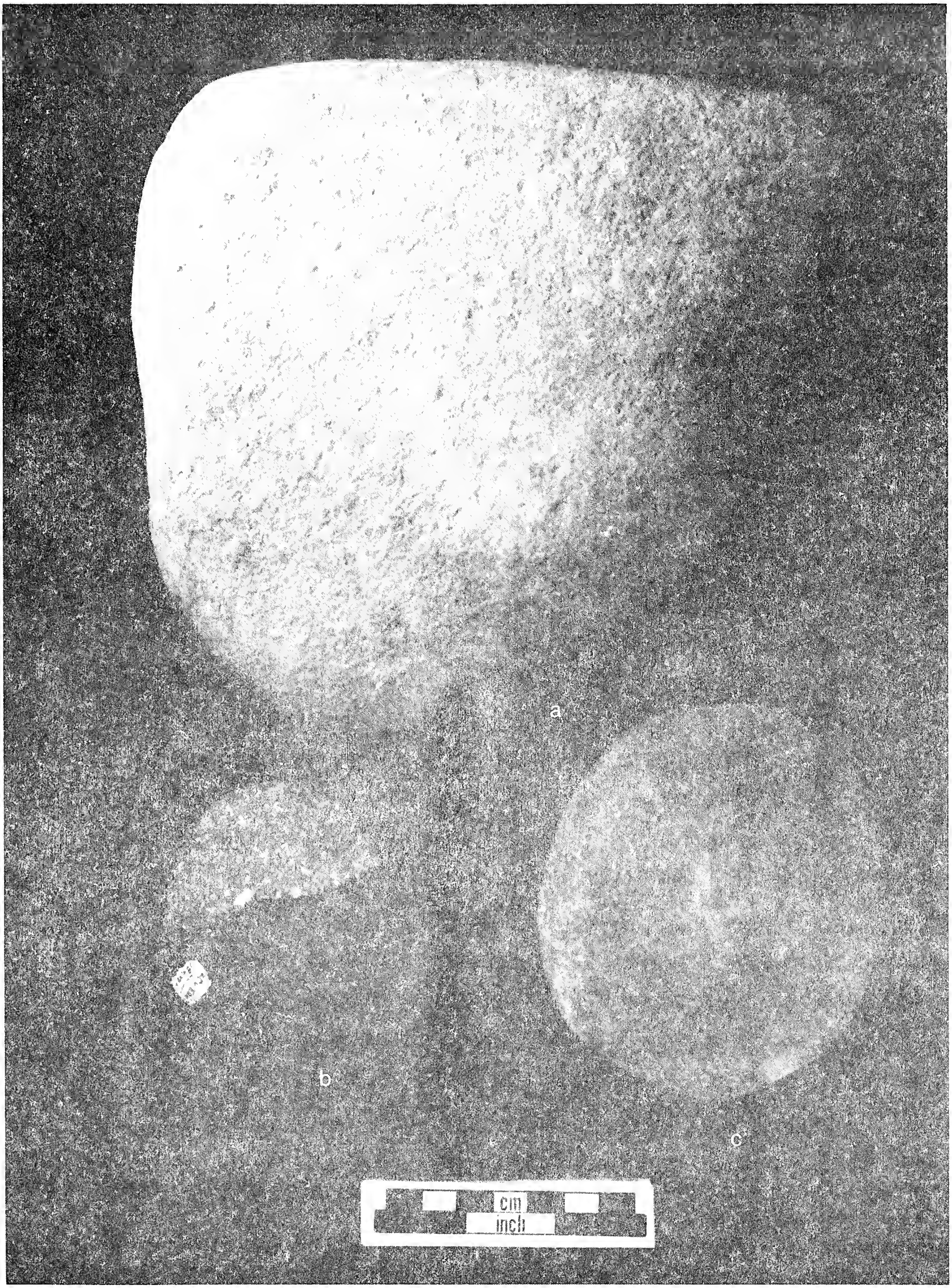


Figure 14. Selected groundstone and use modified tools from the Higgins site.

portions were used as blanks for bifacial reduction. Many bifaces still retain cobble cortex on both ends of the biface, and have been extensively thinned solely by lateral flake removal.

Late Archaic Bare Island points were apparently hafted by socketing which extended to the shoulders. The blade edges on many points of this type in the Higgins Site collection were dulled just above the shoulders, probably to avoid cutting the lashings. Edge modification on resharpened points also stops at the beginning of the dulled area, often leaving a perceptible angle on the blade edge.

Features which date to the Late Archaic include several small clusters of fire-cracked rock, as well as larger hearths up to a meter in diameter (Figure 15). Pollen studies of several of these features indicate the presence of excessive pine and spruce pollen even though these species are absent in the general profile for this time. Possibly this reflects use of sticky, waterproof pine or spruce bark containers for cooking by stone boiling.

Middle Archaic Component

A substantial Otter Creek component was found on the Higgins site, located primarily in Block 3. Large broad-bladed side-notched points of this type have never been reliably dated in the Middle Atlantic area but are considered here to be representative of the Middle Archaic period. Points of the Brewerton side-notched and eared-notched series found at the Higgins site are believed to date to this time period as well. Similar broad, side-notched point styles are known to occur quite early in the Southeast and the Mississippi valley, having been associated with Early Archaic remains in sites such as Russell Cave (Griffin 1974) and the Stanfield-Worley Rockshelter (DeJarnette et al. 1962) in Alabama, Modoc Rockshelter in Illinois (Fowler 1959), and possibly the Flint Run complex in Virginia (Gardner 1974). The type site for Otter Creek points, however, is located in Vermont where the component is dated to about 2000 B.C. (Ritchie 1971). In the far Northeast these points are also associated with ground slate artifacts often oriented towards fishing activities. This associated assemblage is not found in sites further to the south. Although many archeologists in the Middle Atlantic area traditionally place Otter Creek and Brewerton points in the Late Archaic, this view has recently been re-evaluated (George and Davis 1986, Funk 1988). It is suggested that this cluster of types originated in the southeast and was adopted later in the north.

The near absence of the side-notched points from the plowzone and their relative abundance in the subsoil suggests that they are older than the Late Archaic stemmed points. These stemmed points have firm Late Archaic associations in the Middle-Atlantic area (Kinsey 1959) and are plentiful in surface collections and the plowzone. This distribution also indicates that historic plowing has destroyed some of the previously existing stratification on the Higgins site.

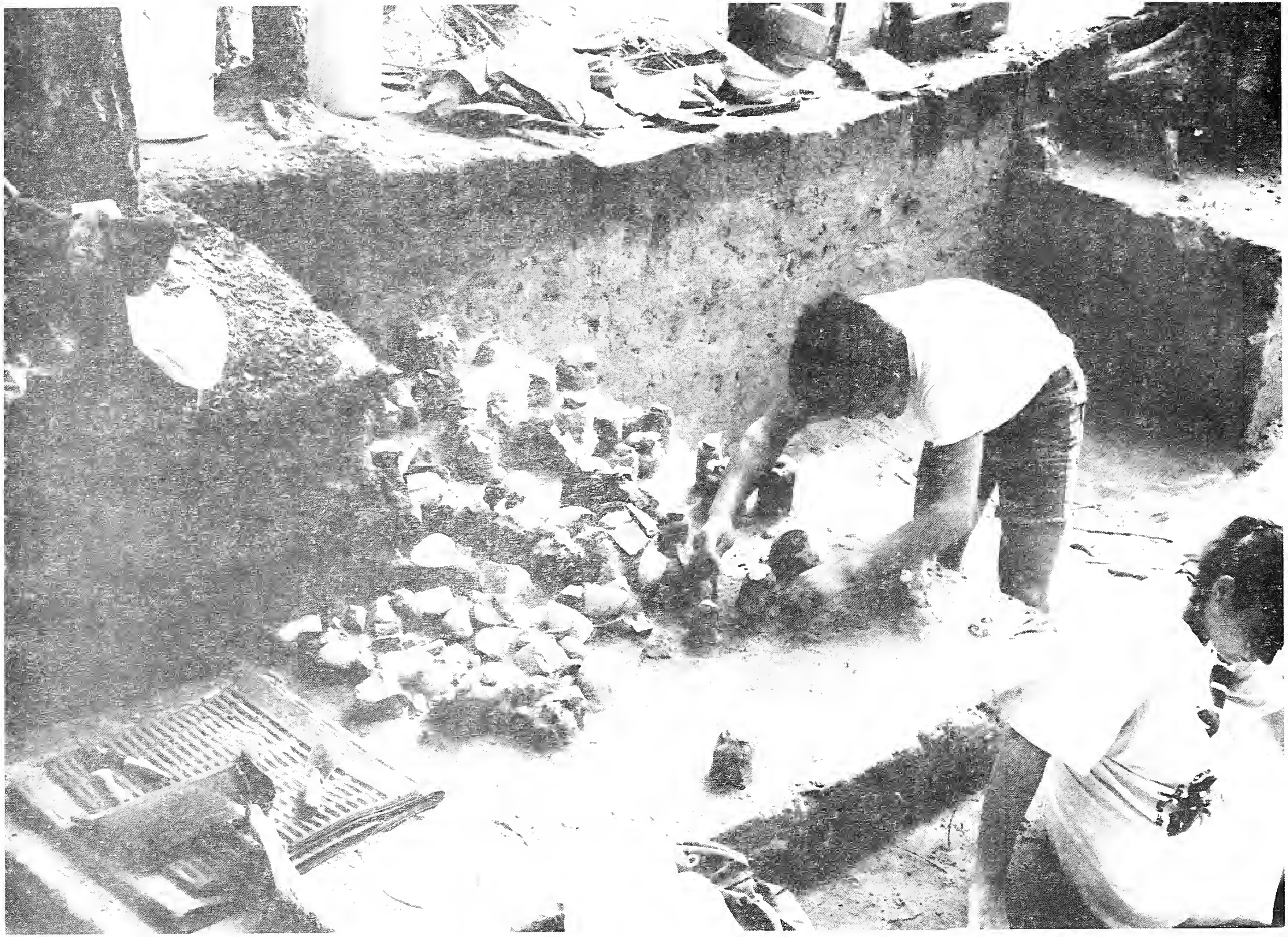


Figure 15. Feature 29, a large Late Archaic hearth, was exposed in Block C. This occupation area was stratified above Paleoindian remains.

The Otter Creek points (Figure 12, e-j) are interesting for reasons other than chronology. Made of rhyolite, quartz and quartzite, several have a unique wear pattern providing insights on their use. Few of the 25 points of this type found on the Higgins site have impact fractures, but five show clear evidence of use as scrapers. The "scraper" points typically exhibit polish or dulling on one lateral edge; often this wear extends over the flake scar ridges on one adjacent face as well. Many of the Otter Creek specimens have been resharpened by narrowing the width of the blade, occasionally to the extent that the shoulders have been nearly eliminated. The reworking scheme differs from that involved in the resharpening of points used as projectiles, in which blade length is affected. The fact that the edge wear on the "scraper" points is unilateral implies that the points were hafted in such a way that the handedness of the user controlled the pattern of wear.

The large number of heavily worn but unbroken rhyolite points discarded at the site may indicate that the Otter Creek people used the Higgins site as a retooling station in conjunction with other activities. New Otter Creek points were made of local quartz which may, themselves, have been discarded when the group returned to the vicinity of the rhyolite quarries in central Maryland.

Consistent pollen profiles from Otter Creek points provided environmental data for the Middle Archaic period as well. This may indicate an increase in nut-bearing trees and a relatively closed forest lacking much scrub vegetation suitable for browsing.

Early Archaic Component

Early Archaic remains are sparse and were recovered largely from Block 2. These include several quartz and rhyolite LeCroy points (Figure 12, m-o). Two amphibolite pestle fragments of the roller type were also found in this vicinity and may be related to the Early Archaic component (Figure 13, b-c). A small number of rhyolite side-notched points recovered from this area may also be Early Archaic in age (Figure 12, k-l). These are dissimilar to the Middle Archaic Otter Creek points in the morphology of the haft element, and in wear patterns, and have not been assigned to a specific type.

A number of additional small clusters of fire-cracked rock were found in the expanded excavations. When plotted with those located during testing, these form a rough semi-circle, possibly around the northern perimeter of the limonite slab concentration. Additional excavation around the limonite failed to further elucidate its origin or possible function. No southern or western boundary was exposed; nor was an interior "empty" space defined, which would have been expected if the rocks marked the perimeter of a shelter. In spite of this, high densities of debitage were concentrated around the "outside" of the northern edge, while projectile points were located in the "interior". Geological consultant Frank Vento believes the limonite to have been transported to its location by humans. Further excavation, however, is necessary to fully expose the remainder of the concentration, and assess its function.

Pollen chemically washed from Early Archaic projectile points yielded strong percentages of non-arboreal pollen, suggesting that the local environment was an open deciduous forest with large areas of scrub vegetation.

Paleoindian Component

Major excavations in the northern portion of Block 1 revealed the first instance of clear stratification on the site, and the presence of a previously undetected Paleoindian occupation. The Paleoindian remains were found underlying a particularly intense Late Archaic complex of features concentrated in levels 2 and 3.

The Paleoindian component at the Higgins site was identified by the presence of three quartz fluted point fragments representing the basal portions of two fluted points (Figure 16, a-b). Associated with these points were several scrapers (Figure 16, c-g) manufactured from a pale to dark green chert which is tentatively identified as Coxsackie flint from the Normanskill formation in the Hudson Valley in New York (Figure 1). This and other varieties of chert were also used to make tools such as gravers (Figure 15, h), pieces esquillees (Figure 16, i-j), and flake tools (Figure 16, k-n). Yellow, brown, and red jaspers, probably from both the Pennsylvania jasper quarries to the north and from the Flint Run quarries in Virginia, and a mottled cream-colored chert of unknown source were recovered.

In the absence of additional diagnostic artifacts, the presence of chert tools and debitage associated with the Paleoindian remains provided an independent means of defining the extent of the occupation. Chert artifacts are extremely rare on the site but were concentrated in the northern portion of Block 1 in levels 4 through 6 over an area measuring approximately 7 by 9 meters. These are located just south of a now-buried stream channel that may have been the focus of the occupation. The small size of the component, and the heavily worn nature of the broken and discarded tools appears to indicate that the Paleoindian occupation was a small short-term hunting encampment where game was butchered and hides were processed. The pronounced grinding and fracture patterns on the fluted point fragments indicates heavy use. Despite the fact that they were manufactured from quartz which is locally available, there is no evidence in the quartz debitage from this area that the Paleoindians made either these or other points on the site. Chert debitage is strongly biased toward small tertiary flakes produced during tool maintenance. Virtually all of the larger secondary and rare primary chert flakes have been retouched and/or utilized.

Pollen and micro-residue data gathered from the Paleoindian component documents an environment not highly dissimilar to our own. A deciduous forest adapted to a streamside/swampy environment was present, with oak gradually increasing at the expense of hemlock. A small fire-cracked rock cluster (Figure 17) found near one of fluted point fragments contained microscopic turkey feather fibers and pollen from oak, willow, hemlock, hickory, and maple trees. Hickory phytoliths found on one of the fluted point fragments possibly indicate hafting on a hickory foreshaft.

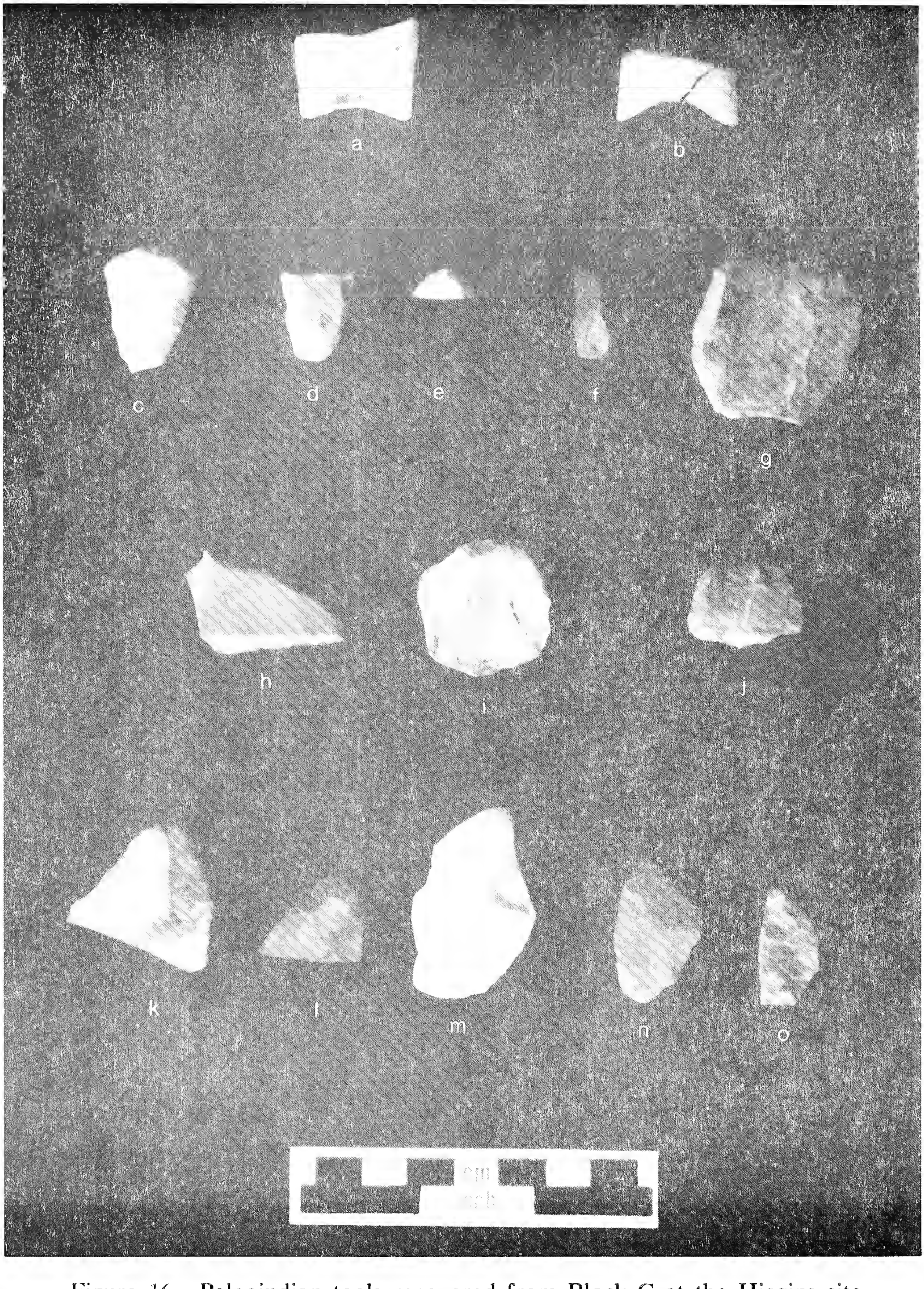


Figure 16. Paleoindian tools recovered from Block C at the Higgins site.

Figure 17. Feature 32, a small fire-cracked rock cluster associated with the Paleoindian occupation, contained turkey feather fibers.

Conclusions

Archeological excavations at the Higgins site have provided a rare opportunity for a clear look into the lifestyles of Maryland's earliest inhabitants of 3,000 to 12,000 years ago. Examination of the earliest intact occupation in the state of Maryland revealed a

surprisingly modern environment inhabited by a wide-ranging small group of Paleoindians. The Archaic period occupation was much more intense with many groups of Indians revisiting the site over a long period of time. Quartz tool manufacture was a focus of these groups, however, close examination of their discarded tools indicates that many other activities occurred here as well. By Woodland times, the Higgins site appears to have been visited sporadically and briefly, probably more to make use of its seasonal floral and faunal resources than to take advantage of the plentiful quartz cobbles. At least one group, however, stayed long enough to make transporting bulky pottery to the site worthwhile. Their broken Marcey Creek pot has provided new insight into the first type of pottery manufactured in this area.

Ongoing investigations of the Higgins data will continue to provide much needed information about these groups and their interaction with their environment. This will include the incorporation of detailed geological and additional botanical studies into the archeological analysis results.

Many sites in Maryland, similar to the Higgins site, hold vital clues to Native American prehistory. Unfortunately, many are rapidly being destroyed by development and their irreplaceable information lost. Although state and federal legislation can provide some protection to a limited number of sites, the assistance of the public, in conscientiously reporting site locations and allowing their collections to be recorded, is essential to stem the loss of these unique, non-renewable resources.

Acknowledgements

Funding for the Higgins site excavations was provided by the Maryland State Railroad Administration and administered through the State Highway Administration. The extensive amount of excavation completed during 1988 would not have possible without the assistance of an exceptional field crew including Esther White, Assistant Field Director, and crew members David Bibler, Dan Bilderback, Chris Civello, Allison Coerper, Tim Currey, Web Dorshow, Jennifer Germer, Debbie Greist, Garry Guan, Scott Lee, Veronica Reigle, and Lisa Rodriguez. Highway Archeology Program Director Ira Beckerman served as project manager. State Archeologist Tyler Bastian and Research Director Dennis Curry provided support and commented on an earlier draft of this paper. Finally, we express our sincere appreciation to T.D. Jones and Edward Higgins for having the foresight to record the provenances of the artifacts in their private collections, and sharing them with the people of Maryland.

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A Check-list of the Skippers and Butterflies of Howard County, Maryland

John H. Fales and Richard H. Smith, Jr.

Howard County, with an area of only 251 square miles, is the second smallest county in the State of Maryland. It is located in the southeastern part of the Piedmont Plateau (Figure 1), which covers the central Maryland region and includes Baltimore, Carroll, Cecil (in part), Frederick (in part), Harford, and Montgomery Counties. The eastern boundary of Howard County follows a line approximating the Baltimore and Ohio Railroad, slightly east of the Fall Line, which separates the Coastal Plain from the Piedmont Province. The Fall Line runs northeastward through Washington D.C., Baltimore, and Havre de Grace. The Fall Line receives its name from the falls and rapids that develop where streams flow from the hard granitic and allied rocks of the Piedmont, onto the unconsolidated sediments of the adjacent Coastal Plain. The Piedmont Plateau extends from the Fall Line west to the Blue Ridge, and has more topographic relief and higher elevations (averaging about 400 and reaching 1000 feet) than the Coastal Plain, which typically does not exceed 100 feet.

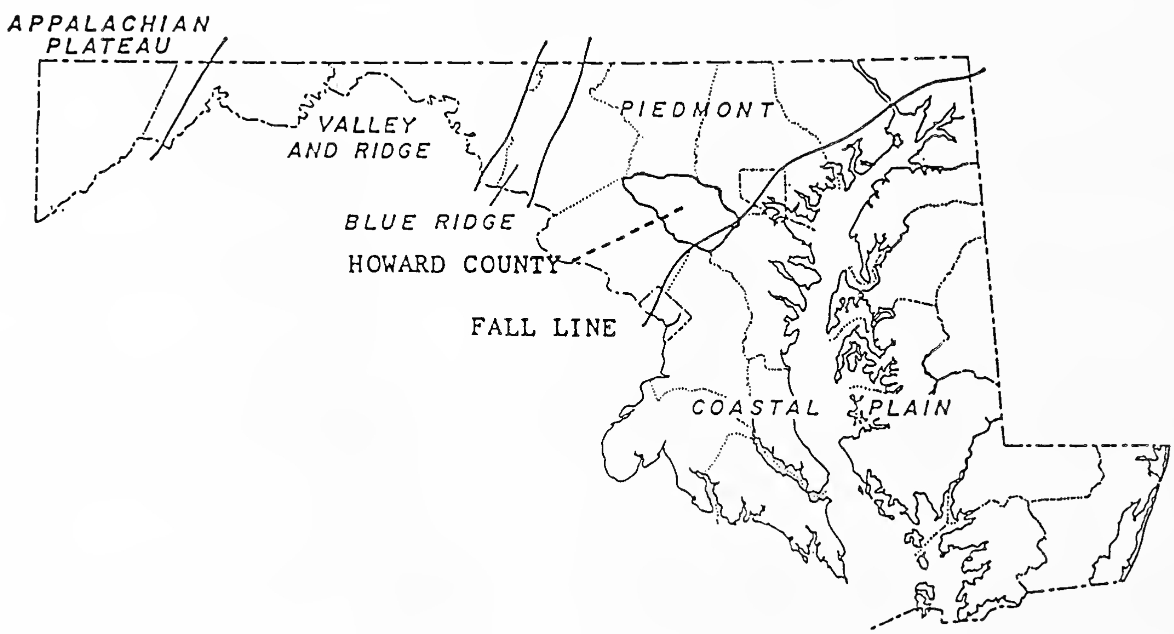

Figure 1. Map of Maryland showing position of Howard County in relation to the Fall Line, which separates the Atlantic Coastal Plain from the Piedmont Physiographic Province (modified from Edwards 1981).

Howard County has a generally oval shape. Its long axis runs northwest from Elkridge near the edge of Baltimore City, and extends westward two-thirds of the distance to the City of Frederick. It is bounded by the Patapsco River on the north and northeast, and the Patuxent River on the south. As mentioned previously, its southeast to northeast boundary primarily follows the Baltimore and Ohio Railroad just east of the Fall Line. Howard County is the only county in Maryland entirely surrounded by other Maryland Counties. Its softly-rolling countryside embraces a land of rich fertility, and the average temperature is 54 F (Gannett 1976, Stein 1972, Vokes 1957).

Howard County has experienced rapid growth in the past 30 years, during which its population climbed from 36,000 people in the late 1950's to over 159,000 today. Only the western portion of the county is still primarily rural, and increased urbanization with its associated loss of natural habitat is sure to continue (Lazarick 1988). Thus, it is useful to publish a summary check-list for Howard County at this time to form a baseline of once resident species before urbanization and the inevitable loss of habitat take their toll.

Fales (1974) listed 70 species of skippers and butterflies from the Piedmont Region. The list of species known to us to occur in Howard County is given below, and includes information gathered by the writers from their own experiences, and also from personal communications with other collectors, namely William A. Andersen, Robert S. Bryant, William R. Grooms, Bryant Mather, Raymond B. Nagle and Robert S. Simmons (now deceased). The scientific names follow Miller and Brown (1981), and common names follow Opler and Krizek (1983).

HESPERIIDAE (SKIPPERS)

Epargyreus clarus (Cramer), Silver-spotted Skipper
Achalarus lyciades (Geyer), Hoary Edge
Thorybes pylades (Scudder), Northern Cloudy Wing
Staphylus hayhurstii (W.H. Edwards), Southern Sooty Wing
Eurynnis icelus (Scudder & Burgess), Dreamy Dusky Wing
Erynnis brizo (Boisduval & Leconte), Sleepy Dusky Wing
Erynnis juvenalis (Fabricius), Juvenal's Dusky Wing
Erynnis horatius (Scudder & Burgess), Horace's Dusky Wing
Erynnis baptisiae (Forbes), Wild Indigo Dusky Wing
Pyrgus communus (Grote), Checkered Skipper
Pholisora catullus (Fabricius), Common Sooty Wing
Nastra lherminier (Latreille), Swarthy Skipper
Lerema accius (J.E. Smith), Clouded Skipper
Ancyloxypha numitor (Fabricius), Least Skipper
Thymelicus lineola (Ochsenheimer), European Skipper
Hylephila phyleus (Drury), Fiery Skipper
Hespera leonardus Harris, Leonard's Skipper
Polites coras (Cramer), Peck's Skipper

Polites themistocles (Latreille), Tawny-edged Skipper
Polites origenes (Fabricius), Cross Line Skipper
Wallengrenia egeremet (Scudder), Northern Broken Dash
Pompeius verna (W.H. Edwards), Little Glassy Wing
Atalopedes campestris (Boisduval), Satchem
Atrytone logan (W.H. Edwards), Delaware Skipper
Poanes massasoit (Scudder), Mulberry Wing
Poanes hobomok (Harris), Northern Golden Skipper
Poanes zabulon (Boisduval & Leconte), Southern Golden Skipper
Euphyes conspicua (W.H. Edwards), Black Dash
Euphyes ruricola (Boisduval), Dun Skipper
Atrytonopsis hianna (Scudder), Dusted Skipper
Amblyscirtes vialis (W.H. Edwards), Roadside Skipper

PAPILIONIDAE (SWALLOWTAILS)

Battus philenor (Linnaeus), Pipe Vine Swallowtail
Eurytides marcellus (Cramer), Zebra Swallowtail
Papilo polyxenes Fabricius, Black Swallowtail
Pterourus glaucus (Linnaeus), Tiger Swallowtail
Pterourus troilus (Linnaeus), Spicebush Swallowtail

PIERIDAE (WHITES AND SULPHURS)

Pontia protodice (Boisduval & Leconte), Checkered White
Artogeia rapae (Linnaeus), European Cabbage Butterfly
Falcapica midea (Hubner), Falcate Orange Tip
Colias philodice Godart, Clouded Sulphur
Colias eurytheme Boisduval, Orange Sulphur
Phoebis sennae (Linnaeus), Cloudless Sulphur
Pyrisitia lisa (Boisduval & Leconte), Little Sulphur

LYCAENIDAE (HAIRSTREAKS AND RELATIVES)

Feniseca tarquinius (Fabricius), Harvester
Lycaena phlaeas (Linnaeus), American Copper
Hyllolycaena hyllus (Cramer), Bronze Copper
Harkenclenus titus (Fabricius), Coral Hairstreak
Satyrium calanus (Hubner), Banded Hairstreak
Satyrium liparops (Leconte), Striped Hairstreak
Calycopis cecrops (Fabricius), Red-banded Hairstreak
Mitoura gryneus (Hubner), Olive Hairstreak
Incisalia niphon (Hubner), Pine Elfin
Euristrymon ontario (W.H. Edwards), Northern Hairstreak
Parrhasius m-album (Boisduval & Leconte), White M Hairstreak
Strymon melinus (Hubner), Gray Hairstreak
Everes comyntas (Godart), Eastern Tailed Blue
Celastrina ladon (Cramer), Spring Azure

NYMPHALIDAE (BRUSH-FOOTED BUTTERFLIES)

Euptoieta claudia (Cramer), Variegated Fritillary
Speyeria cybele (Fabricius), Great Spangled Fritillary
Speyeria idalia (Drury), Regal Fritillary
Clossiana selene (Denis & Schiffermuller), Silver-bordered Fritillary
Clossiana bellona (Fabricius), Meadow Fritillary
Phyciodes tharos (Drury), Pearl Crescent
Euphydryas phaeton (Drury), Baltimore
Polygonia interrogationis (Fabricius), Question Mark
Polygonia comma (Harris), Comma
Nymphalis antiopa (Linnaeus), Mourning Cloak
Vanessa virginiensis (Drury), American Painted Lady
Vanessa cardui (Linnaeus), Painted Lady
Vanessa atalanta (Linnaeus), Red Admiral
Junonia coenia Hubner, Buckeye
Basilarchia arthemis astyanax (Fabricius), Red-spotted Purple
Basilarchia archippus (Cramer), Viceroy

APATURIDAE (HACKBERRY AND GOATWEED BUTTERFLIES)

Asterocampa celtis (Boisduval & Leconte), Hackberry Butterfly
Asterocampa clyton (Boisduval & Leconte), Tawny Emperor

SATYRIDAE (SATYRS AND WOOD NYMPHS)

Enodia anthedon A.H. Clark, Northern Pearly Eye
Satyrodes appalachia R.L. Chermock, Appalachian Eyed Brown
Megisto cymela (Cramer), Little Wood Satyr
Cercyonis pegala (Fabricius), Common Wood Nymph

DANAIDAE (MONARCHS)

Danaus plexippus (Linnaeus), Monarch

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The Freshwater Jellyfish, *Craspedacusta sowerbyi*, on Maryland's Eastern Shore (Hydrozoa: Hydroida: Petasidae)

William L. Grogan, Jr.

The freshwater jellyfish, *Craspedacusta sowerbyi* Lankester, is an atypical member of the Class Hydrozoa in that the free-swimming medusa or jellyfish stage is large and obvious, while the polyp or hydroid stage is small, non-tentacled and colonial (Barnes 1987, Hyman 1940). This species was originally considered to be a native of the Amazon basin of Brazil and from there transported on water lilies to England where it was discovered in 1880 (Hyman 1940). It is now generally accepted that it was indigenous to China (Kramp 1950) and from there it has been introduced to Europe and North America (Hutchinson 1967, Pennak 1978).

Rivers (1987) provided the first records of this species from Maryland. She reported a sighting of freshwater jellyfish in Clopper Lake in Montgomery County by Maryland Department of Natural Resources fisheries biologists. She also received a report of this species from the owner of a private pond in Washington County. She visited the pond and found specimens to be abundant and active at dusk.

During late September 1984 while on a fishing trip in Galestown Pond in Dorchester County, I noticed numerous individuals of this species as they actively swam during the late afternoon and evening hours. Specimens were captured and examined, and ranged from approximately 10 to 20 mm in diameter. Although I had previously heard of freshwater jellyfish, I did not realize that there were no actual records from Maryland, therefore no attempt was made to preserve specimens. It was not until I read the report by Rivers (1987) that I recognized the significance of my observations. Attempts to find additional specimens at this locality on subsequent occasions have been fruitless.

This is apparently the first record of this species from the Coastal Plain of Maryland. Galestown Pond is an impoundment of approximately 15 surface acres and was formed by damming Gales Creek, which flows into the Nanticoke River just west of the Maryland-Delaware line. This pond is shallow, very clear, with a maximum depth of 2 meters, and supports an abundance of submerged aquatic vegetation such as *Vallisneria* and *Potamogeton*, and emergent species such as white (*Nymphaea*) and yellow (*Nuphar*) water lilies. These aquatic plants provide abundant attachment sites for the small and inconspicuous polyps of *Craspedacusta*. Under certain environmental conditions, these polyps produce buds that break away and mature into the free-swimming adult medusae or jellyfish.

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The Wood Turtle, *Clemmys insculpta*, on the Maryland Coastal Plain

Arnold Norden and John Zyla

The wood turtle is one of the largest and most distinctive terrestrial turtles in North America (Figure 1). It ranges from northern Virginia and the eastern corner of West Virginia north through Maryland and Pennsylvania into New England to Nova Scotia, and west around the Great Lakes to eastern Minnesota. As its name implies, it occurs in wooded areas, particularly where streams are present. Although frequently found on land, *C. insculpta* freely enters streams, and typically hibernates and mates under water. In addition to being locally abundant, large, attractive, and having very interesting habits, this species is considered quite intelligent for a reptile and has always been a favorite of turtle fanciers and other natural history buffs.

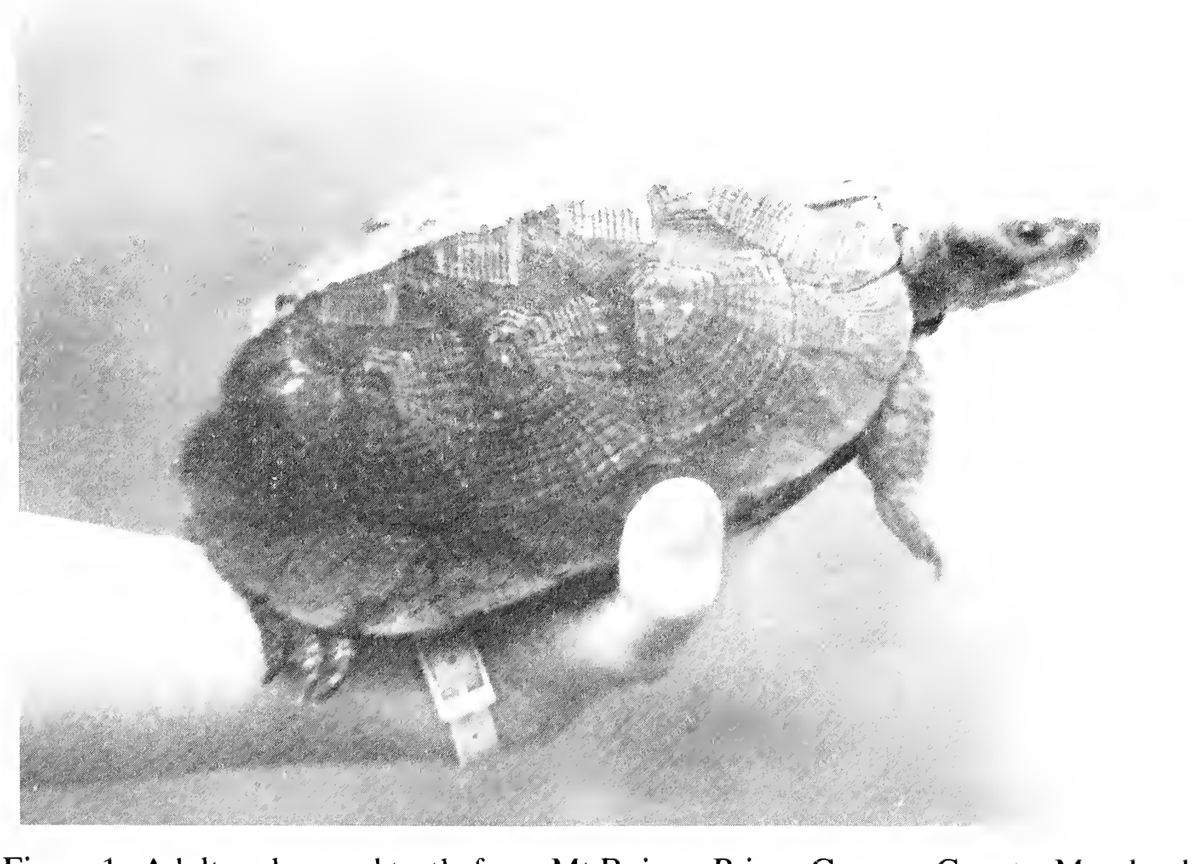

Figure 1. Adult male wood turtle from Mt Rainer, Prince Georges County, Maryland. This specimen is presently on display at the 30th Street Nature Center.

Considering the amount of interest that this large species generates, it might come as a surprise to learn that the extent of its distribution in Maryland has not been accurately determined. The first person to attempt to delineate its local distribution was Robert McCauley (1945), in his classic publication on the Maryland reptiles. He described it as a "common turtle of the Appalachian Province, found occasionally on the Piedmont Plateau. It is entirely absent from the Coastal Plain." McCauley's monograph was followed by a detailed survey of the Maryland reptiles by Cooper (1960) and a summary of the known information on local turtles by Schwartz (1967), both of which followed McCauley in depicting *Clemmys insculpta* as a species typically found west of the Fall Line, but never east of it. Harris, in his first distributional survey (1969) followed these earlier accounts, but in his second version (1975) showed one record for the Coastal Plain at Elk Neck in Cecil County. The only other author to actually give Coastal Plain records for this species was Carl Ernst (1972), who published a map showing it to be generally distributed west of the Fall Line but included two records for the Maryland Coastal Plain, one north-west of Annapolis and the other in eastern Charles County.

We should also mention a single specimen found in Talbot County and reported by Norman (1939). That individual has usually been considered to be a released specimen, and not evidence of a population existing on the lower Delmarva. Since no other wood turtles have been reported from the eastern shore, that assumption may be correct. However, as pointed out by Reed (1956, 1958), several typically Piedmont species of animals and plants do have disjunct populations in that area.

Our interest in the distribution of this species in Maryland was sparked by a casual discussion, during which it became obvious that each of us knew of several records for wood turtles on the Coastal Plain. Combined, and augmented by records supplied by Sam Lyon and others, these sightings make it clear that *Clemmys insculpta* is at least locally common on the Coastal Plain along the western side of the Chesapeake Bay (Figure 2). The number of specimens found in that area over the years clearly indicates the presence of a viable population, and the hatchling from Greenbelt is evidence of recent reproduction. Unreported Coastal Plain records known to us are given below and shown on the map in Figure 2.

Anne Arundel County:

Crushed adult found along the south side of Route 50 just east of the South River Bridge by A. Norden. June 1971.

Adult found in field along Jumpers Hole Road, Elvaton. Summer 1975. Shown to A. Norden by Clyde Prince.

Adult found along shoulder of I-97 near exit for Old Generals Highway by Grace Matheny. Late May 1989.

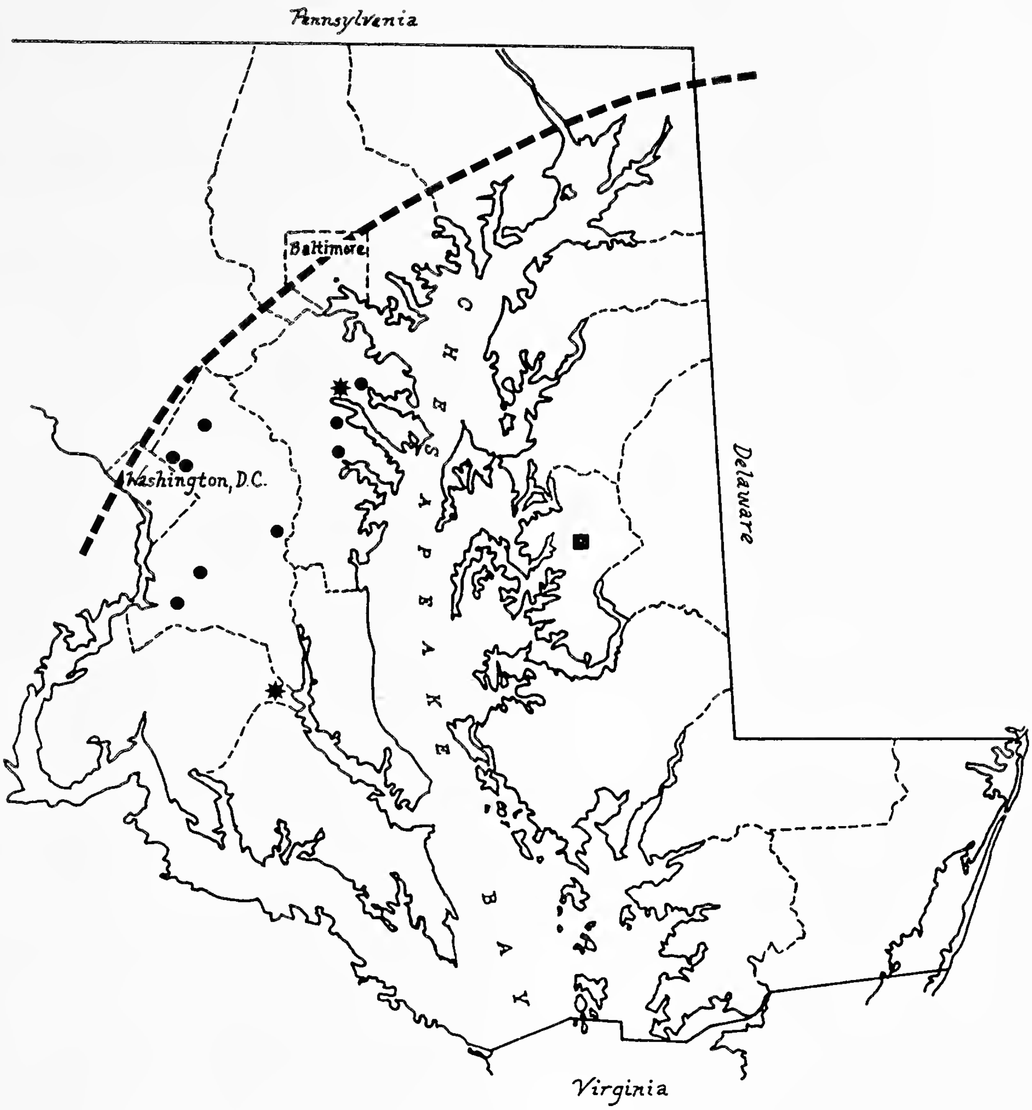

Figure 2. Map of eastern Maryland showing Coastal Plain localities for wood turtles reported above (●), shown by Ernst (1971) (✱), or reported by Norman (1939) (■). Heavy dashed line indicates approximate location of Fall Line, which separates the Atlantic Coastal Plain from the Piedmont Province.

Prince Georges County:

Newly hatched individual (37 mm in length) found in stairwell at Greenbelt Community Church, Greenbelt, by Beth B. Norden. 30 September 1989. Presently in captivity at Eleanor Roosevelt High School.

Adult female found near junction of Ridge and Research Roads, Greenbelt, by Sherna Comerford. 25 June 1990. Presently on display at Nature Center, Watkins Regional Park. This individual laid eight eggs after several weeks of captivity.

Adult observed along Anacostia River near Colmar Manor by Lisa Bierer. Summer 1989.

Adult found at junction of Route 501 and Queens Chapel Road, Mt Rainer, by Lisa Bierer. Summer 1989. Presently on display at 30th Street Nature Center.

Adult found in gravel pit near junction of Butler's Branch and Brandywine Roads, Clinton. June 1974. Specimen brought to Clearwater Nature Center.

Adult found at old Shreeve Property near junction of Route 5 and Route 223. June 1975. Specimen brought to Clearwater Nature Center.

Adult found by Marilyn Cable at junction of Washington Road and Tantallion Drive in Fort Washington Estates, Fort Washington. 17 June, 1988. Specimen now at Clearwater Nature Center.

Adult found crossing Route 4 just NE of Upper Marlboro. Summer 1958. Specimen brought to Clearwater Nature Center.

Adult found in field along Piscataway Creek Road at Piscataway Creek. 22 April 1990. Specimen brought to Clearwater Nature Center.

Acknowledgements: We would like to thank Ms. Lisa Bierer, Ms. Sherna Comerford, Mr. Sam Lyon, Mrs. Grace Matheny, and Dr. Beth Norden for providing information on wood turtles that they have collected or seen. We also thank Lisa Bierer of the 30th Street Nature Center, for allowing us to photograph the specimen shown in Figure 1.

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Arnold W. Norden, Editor

Mailing Date: October 16, 1991

Cover Illustration: The Climbing fern, *Lygodium palmatum*, is rare in Maryland, where it is known from only 8 locations. It is currently listed as a Threatened species by the Maryland Department of Natural Resources. This is an original drawing by Josephine B. Thoms, from a photograph by L. Harrison Wiegand.

Miss Mary E. Banning
Maryland's first mycologist

HAK

Portrait of Mary Banning taken in Winchester, Virginia circa 1890.

Mary Banning: The Woman Who Painted Mushrooms

The following brief, unsigned biography, along with several long-forgotten articles, a few personal letters, and an exceptional unpublished illustrated manuscript, is all that is remembered of the remarkable life of Mary Elizabeth Banning, 1822-1903. The biography is believed to be the work of Dr. Howard Kelly, a Baltimore surgeon and one of the founders of the Natural History Society of Maryland, and it appears to have been written sometime after February of 1919. It has remained unregarded in the archives of that society until it recently attracted the attention of Arnold Norden. The biography draws heavily on Banning's surviving letters and profusely illustrated manuscript, all of which are now housed at the New York State Museum in Albany, New York. The biography is reproduced here with credit to the sources of information, when they could be determined, but without substantive changes. It is clear from the biography that it's author never met Miss Banning but that he contacted those who had known her.

Mary Banning was an educated and introspective person with an exceptional ability to express herself with either a pen or artist's brush. It appears that she grew up in a happy and privileged environment, but her fortune faded throughout the course of her life and her final years were spent in a modest boarding house, far from the place in Maryland she considered to be her home. She never married and spent much of her life caring for older family members. An overriding feature of most of her life was her passion for natural history and for the world of mushrooms in particular. Had she lived at a time when the scientific community was more accepting of women, she no doubt would have contributed materially to whatever discipline she chose, but in the final quarter of the nineteenth century she worked without much outside encouragement and reached only a small and personal audience. Aside from her unpublished manuscript, she wrote six brief articles which appeared in semi-popular journals. Citations to these are presented in the bibliography at the end of this article. In one of her articles she described three new species of mushrooms, and 16 more were published in the Bulletin of the New York State Museum (Peck 1891). In some respects her dilemma was parallel to that of Beatrix Potter, who also aspired to do scientific work with fungi. Mary had the ability to write and paint straight from her heart without the protective mechanisms of academic vocabulary or formal art training. It is the sincerity and openness in her work that I find the most alluring, but it is also the feature that left her open to the most criticism by which she was deeply hurt.

Miss Banning's mentor in mycology (the study of fungi) was Dr. Charles H. Peck of the New York State Museum in Albany, New York. He was at the center of mycology in North America during the last quarter of the nineteenth century, and he helped many people in that field regardless of whether or not they had formal scientific training (Haines 1986). Miss Banning sent many of her scientific specimens to Peck and they are still curated at the New York State Museum. He corresponded with Mary from 1879 until 1897, but they never met in person. Their personalities as portrayed in their letters could not be more different. Where Mary wrote of sporadic exciting mycological adventures and of personal sorrows, Peck wrote scientific descriptions in Latin, and kept a steady scientific

pace during his forty-seven-year professional career. There is a comment in one of Mary's letters that revealed that he thought some of her paintings were "unscientific," but there is no record of his thoughts of their artistic quality. When he finally published her list of Maryland fungi, in the Annual Report of the New York State Museum of Natural History in 1891, all of the romance was removed and only the terse Latin descriptions remained. From that report no one can see that the real book, the illustrated manuscript she sent to the museum and that formed the basis of the report, is a remarkable document that has much to tell about life as well as about mushrooms.

My involvement with the work of Mary Banning started when I came to the New York State Museum in 1969 to take on part of the mycological work started by Charles Peck more than a century before. Perhaps because I professed an interest in old mycological books, I was shown an oversize volume stamped "The Fungi of Maryland, M. E. Banning" in gold leaf on the cover. I was allowed only a brief glimpse of its bright illustrations by it's protective curator. It was only later that I realized that this "book" was not a book at all, but an unpublished manuscript. A few years later I took on some new responsibilities which included the curation of the mycological collection where the manuscript was kept. My first act was to retrieve the manuscript from the herbarium where it had been stored, to my office where I could examine it in detail. The herbarium had been moved after Peck's death in 1916 to a part of the museum where it was separated from the public gallery area by a wall formed by an exhibit of stuffed chickens. The area was noisy and dimly lighted by a few bare, hanging bulbs, but what was worse was that air ducts had blown a constant suspension of coal dust from the city. The manuscript was in the bottom drawer of the same cabinets which housed Dr. Peck's scientific specimens of fungi. When the pages were finally opened to the light in my office, the vivid paintings fairly glowed off the bright white bristol board leaves with only a little coal dust at the edges. They were in almost perfect condition and had probably not been thoroughly examined for almost a century. The paintings seem a little exaggerated, euphoric perhaps, often without the little imperfections one would expect, and in color so intense that it can only have come from her mind's eye. They have a personal, even intimate, quality that transcends their mundane subject matter and illustrates the pain and joy of the artist. I immediately proposed an exhibit of some of the paintings at the New York State Museum, and I was so engaged with the paintings that I had not read the text until weeks later. The stories in the text were the vivid word equivalent of the folk art paintings. It was only as I put together an exhibit that I realized how little I could find about the life of the artist. A small bundle of letters from Banning was found among Peck's correspondence, and a few words about her appear in the History of Talbot County, Maryland, where she was born, but nothing else had been located until the discovery of this brief biography by Arnold Norden. Although much of the information in the biography is repeated from the letters and manuscript, it contains some additional vital statistics, some second-hand recollections, and the only photograph of Mary Banning known to me.

The paintings have now been separated from their binding, and carefully cleaned with help from professional art restorers, matted, and selected ones expertly framed. They have been exhibited once at the New York State Museum, in 1981, and once at the Buffalo Museum of Science, in 1986. Mary Banning's manuscript has been edited, some of her best paintings selected, and a foreword written in order to attract a publisher, but so far Miss Banning's own words written in 1887 to Professor W. G. Farlow, of Harvard University, sum

up the situation. She wrote "My illustrated book of Maryland Fungi is greatly enlarged since you saw it. It will never be published because of the expense". I have been captivated by this book, perhaps in a small way as Mary Banning was captivated by her mushrooms and I want more than anything to see her book printed for all to see. I think of it often, so you can imagine my surprise when Arnold Norden, a person unknown to me at the time, phoned to ask me if I knew anything about Mary Banning because he found an unsigned biography of her that he wanted to have published. We rapidly exchanged information. As I read the anxiously awaited biography, I was again shocked to see some of the same quotations from Peck's letter file that I had used in my unpublished foreword. It became clear that the letters I assiduously tracked down to a cardboard box in the back room of the herbarium, and which I thought had been unknown and undisturbed for almost a century, had been copied and sent to Dr. Kelly early in this century by Peck's successor, Dr. Homer D. House.

It is hoped that, through the publication of this biography, we can have a small glimpse into the life of a dedicated natural historian from a different era, and that by some remote chance more information about Mary Banning and her art may come to light.

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September 6, 1991

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One of the 175 watercolor illustrations from Mary Banning's unpublished manuscript "The Fungi of Maryland". Polyporus beattiei was never officially published in the scientific literature and exists only in this painting.

The Biography of Mary E.Banning

The history of Talbot County makes interesting and pleasant reading, for it is closely associated with the commercial, educational and religious annals of Maryland. Situated on a part of the section known as the "Eastern Shore", it is largely surrounded by water--with Tuckahoe Creek and Choptank River on the east, the Choptank also on the south, and its western shore washed by the Chesapeake Bay. Its fertile soil has always lent itself to agriculture. Oysters and fish offer natural products for market. In the early history of Maryland, trade with England was thriving and many passengers and rich freights landed at the port of Oxford, on the arm of the Chesapeake.

A notable feature of life in the county was the building of substantial homes, some of which are still standing, while others have been replaced by larger, handsomer houses built on the sites of the first buildings. In a frame cottage, chief house on the family plantation which bore the name of the "Isthmus", was born on April 6, 1822 Mary Elizabeth Banning, youngest child of Robert Banning and his second wife Eliza Makin. The "Isthmus" is in Hopkin's Neck, about half way between St. Michael's and Easton; it fronts on Plaindealing Creek near the mouth, and the old town of Oxford is in full view. The original house has been torn down and replaced by a new and more modern one. Many years ago the house passed from the Banning family.

James Banning, grandfather (1) of Mary, at his death left a widow, Jane Banning (who later married Nicholas Goldborough) and three sons, whom their step-father adopted and to whom he left property. The eldest of these boys was Jeremiah, born march 25, 1733, and he, following after many a Talbot lad, turned to the sea for occupation, and at the age of nineteen sailed in the "Nancy of London". From that time, he spent much time at sea. During his seafaring life he recorded his experiences in a "day book" which was kept faithfully and bequeathed to his descendants. (2) His last voyage was in 1772, after which he settled in his native county taking active part in military and political life, his patriotism being a leading quality in all his affairs.

Washington appointed him collector of the port of Oxford in 1789; he was a member of the vestry of St. Michael's Parish and was a magistrate; and he died on December 23, 1798, at his home, the "Isthmus", and was buried on the grounds. He left three children, Robert, Freeborn and Clementina.

Robert, the eldest, born at the "Isthmus" , January 16, 1776, was educated in Talbot County, then assisted his father at the Custom House, and at the age of nineteen was appointed by Washington as "Inspector of the Revenue for the several ports within the District of Oxford." In 1798 President Adams appointed him to succeed his father as Collector of Customs, and he retained this post until removed by Jefferson in 1804. He was a member of the General Assembly in 1812, 1817, 1825-1826; he commanded a company

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1. James Banning is Mary's great grandfather fide Tilghman 1915.
2. The "day books" were bequeathed to Mary Banning, Tilghman 1915.

of dragoons and did good service in 1812 and 1815. He was a member of the vestry of St. Michael's Parish, a trustee of the poor of the county, and one of the earliest members of the Maryland Agricultural Society.

Freeborn, second son of Jeremiah Banning, was born in 1777 and received his name because his birth occurred soon after Maryland became free. Like his father he felt the call of the sea and while a lad served in the British Navy and later in the navy of the United States; he married a daughter of Captain Henry Geddes and their son was Henry Banning whose son was James Littleton Banning, of Wilmington, Delaware.

Robert Banning at the age of 23 married Susannah Thomas, two years his junior; their children were: Margaret Maria, Jeremiah Oldham, Robert Luther, Susan A., Alexander, Catherine and Harriott Matilda. Robert Banning's wife died in 1820 and soon after he married Eliza Evelina Makin (3) and of this marriage two children were born, Matilda and our botanist Mary Elizabeth. Robert died September 17, 1845, and was buried near his father on the "Isthmus" farm.

When Mary Banning was born, the youngest of nine children, the eldest, Margaret Maria, was twenty-two years old; her own full sister, Matilda, died young and it was Catherine, the half sister, nine years her senior who was the devoted friend and companion of Mary. Little is known of Mary's childhood except that she lived on the old plantation and probably roamed the fields and learned to know and love the outdoor life so freely followed by her father. In 1889 she wrote, "From early childhood "Toad Stools", so called, have claimed my admiration. I am deeply impressed by their mystery and their beauty--perfectly at home in their varied forms and structure long before I had books to teach me classification." (4) Educational advantages at that time were meager in Talbot, but the best obtainable were evidently secured for her benefit, for her general culture, taste in reading, and ease in writing testified to early acquirements; she took pleasure, either then or later, in the study of Latin.

Reared in the teachings and atmosphere of the Episcopal Church and with her family identified with St. Michael's Parish, she was from childhood and throughout her life deeply religious in feeling and devoted to her church duties. She was baptized by Bishop James Kemp (1764-1827) on November 16; her baptism is recorded in St. Michael's Parish Record, giving the date of birth as April 6, 1822. Beside the record is "a loose slip of paper yellowed with age on which Bishop Kemp has evidently written the original certificate... This is very interesting as, so far as I know, it is the only case in our records." (5)

Miss Banning was greatly interested in the young, particularly in their education, and her delight in nature made her long to share this pleasure with the poor and ignorant

3. Mary's mother's name was Mary Macky fide Tilghman 1915.
4. From the preface to her unpublished manuscript "The Fungi of Maryland" dated March 12, 1889. In the collections of the New York State Museum.
5. From a letter to Dr. Kelly from the Rev. J. Cheesley, rector of St. Michael's Parish. Date: 26 February 1919. Present whereabouts unknown.

children around her; this thought was put to practical use, which may be described in her own words. As she was extremely reticent and rarely spoke of personal matters, even to those nearest in blood or association, what she says as quoted is of peculiar interest; another cause of the interest in the following words is that we find there the reason for her undertaking to illustrate the fungi of her native State.

She says:"My first idea of drawing and painting the Fungi of Maryland had for its object educational training in a mission school. I thought that to color and describe them would be the most effectual method of explaining the many abstruse points in structure which might otherwise be forgotten. What more difficult department in Botany could have been selected--what more common objects to the poor boy and girl who roam through the forests and over meadows, daily coming into contact with what they are taught to dread and to name "Toadstools"? I confess to a smile at my choice of a subject, feeling that for once I had stepped from the sublime to the ridiculous. Yet I felt satisfied with my undertaking believing that the study of Natural Science in any of its departments has a refining influence--that when used in its truest highest sense it is the Divinely appointed means of teaching faith as well as of cultivating the mind and the morals. As my work progressed, and even when it closed, so far as the school was concerned, I became deeply interested in the study of Fungi, so that what I had engaged in as a charity became a fascinating occupation." (6)

After the death of her father, in 1845, Mary Banning, then in her early twenties, left her country home and with her mother and sister, Catherine, went to live in Baltimore. Between the two sisters was a deep and abiding love; Mary looked up to and admired Catherine, whose death in 1885 was one of the greatest sorrows of her life.

For many years the sisters lived on Lexington Street, in the neighborhood of Lexington Market, at that time a very nice residential part of the city (7). From Lexington Street Miss Banning moved to 245 West Preston Street which remained her home until she left Baltimore in 1890 (8). During these years she became increasingly absorbed in the study of fungi, which had now become her chief interest; her time was largely given to this subject--to excursions into the woods and fields for specimens, and in making faithful representations by painting them. Her extreme conscientiousness and great sincerity of character were put into the work, and however opinions may differ as to the artistic value of her paintings there can be but one opinion as to her endeavor and careful reproductions.

During this time she completed the great work of her life, a book entitled "The Fungi of Maryland"; this she presented to the New York State Museum of Natural History, where

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6. From the preface to "The Fungi of Maryland".
7. Maria Banning with Catherine F. and Mary E. is listed in Baltimore city directories as living at 77 N Eutaw street from 1856-1857, 360 N Eutaw from 1858-1864, and 280 Lexington Street from 1864-1885, with Maria's name omitted after 1873. All are listed without occupation. JHH.
8. The Baltimore city directory for 1889 shows Mary Banning as the sole occupant of 245 Preston. JHH.

at that time Dr. Charles H. Peck was the State Botanist. The work was dedicated to Dr. Peck, as she says, "in token of thanks for his kindness in helping to determine the numerous fungi of Maryland." (9)

Dr. Peck's remarkable kindness in giving time and knowledge to whomever might ask is well known, and it is said that this generosity was not always appreciated as it deserved and that credit was sometimes omitted in published papers made possible through Dr. Peck's help. In Miss Banning's case full credit was given, grateful acknowledgement made and a generous return is seen in the gift of her *magnum opus* to the Institution beloved by Peck, rather than to one in her native State.

In her preface Miss Banning says: "In Maryland, with few exceptions, fungi are considered vegetable outcasts--like beggars by the wayside dressed in gay attire, they ask for attention but claim none." But these waifs of nature were given full regard by Miss Banning, who prosecuted her studies with vigor, retiring almost entirely from social life in order to have more time for this interest.

A niece of Miss Banning's remembers when a little child going with an older relative to call on her aunt, only to hear her say (She thinks now half-humorously): "Oh, indeed, I am too busy to have visitors: Don't tell people to come to see me!" She went often to the Peabody Institute Library, and Dr. Philip R. Uhler, librarian and later provost of the Peabody Institute, himself a naturalist though not a mycologist, was interested in her and gave help which she acknowledged in her book. Mr, John Parker, the present librarian, remembers Miss Banning as a reader in the Library, and indeed Mr. Parker was the first to give me personal data of this interesting woman, who seemed to be utterly forgotten. He describes her as of stout build, with fair complexion and sandy hair, and with a pleasant although somewhat erratic manner.

Dr. Russell Murdock, of Baltimore, was a helpful friend, and she was most friendly with the family of Dr. William Hand Browne, of the Johns Hopkins University. Dr. Browne aided her in collecting and discovered a plant which she named for him--*Agaricus (Tricholoma) Brownei.* The six children of Mr. Browne were much interested in "Toadstools" and sometimes accompanied Miss Banning on her mycological explorations. On one of these a mushroom joke was played on her that no one enjoyed more than herself. It was in August, 1878, when Miss Banning with Dr. and Mrs. Browne and the children started on their walk, She tells the story: "I must not forget the frisky little dog that went bounding ahead as if he also entered into the spirit of the expedition and wished to become our guide. After reaching the woods Dr. Browne and two of his children led the way for the purpose, as we afterwards found out, of fixing up moss and oak-apples upon sticks to represent agarics and thus deceive the party that followed on. Peals of Laughter rose up as the make-believes were approached and the deception discovered." (10) Two of the "children", Dr. William Hand Browne, Jr., of the North Carolina State College of Agriculture and Engineering, and Dr. Arthur Lee Browne of Baltimore, have written me of pleasant memories of the friend of their childhood.

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9. From the dedication in "The Fungi of Maryland".
10. From the text accompanying plate #38 in "The Fungi of Maryland".

Among Miss Banning's friends must not be omitted John Widgen, the faithful colored janitor of the Maryland Academy of Science who has served there for ____ (sic) years, who knew Miss Banning and sometimes fetched paintings from her home to the Academy. A group of these paintings was presented to the Academy by Miss Banning and may be seen there, unfortunately on the top floor up many stairs.

Mary Banning's "book" is a large manuscript volume containing 175 colored paintings of fungi with descriptions written by hand. The date of the preface is March 12, 1889. Some plates are duplicates "for the purpose of showing the variation in plants bearing the same name". Miss Banning says: "It may be thought by those unacquainted with the glowing colors found among fungi that some of my drawings are the creations of fancy, but such is not the case. I invite the careful observation of the skeptical and they will find that their paintboxes hardly afford pigments bright enough to sketch those beauties of the woods." The book occupied twenty years in the making, but Miss Banning said that it was not so much "a work of labor as of love" (11).

In 1889, Miss Banning suffered with her eyes, but worked at intervals, and by this time she had definitely decided to present her book to the New York State Museum. She wrote to Dr, Peck "My first truly reliable information came from New York, from yourself, thus I feel justly decided in favor of the New York State Museum in preference to all other places. Several of my friends legislate very hard to get the volume for Johns Hopkins University, but I who hold the right to give where I please, am against it" (12).

Again she says of her book "It has cost a considerable amount of Money. In this respect it is valuable if in no other, there is not the slightest prospect of its ever refunding one dollar. The pleasure it has given me is certainly compensating, and as it had no lucrative motive I am satisfied." (13).

On 20 March 1890 she sent her book to the museum and wrote to Dr. Peck, "In parting from it I feel like taking leave of a beloved friend with whom I have spent many pleasant hours....I shall enter it in the express at the value of one hundred dollars, it has cost more than double that sum... My friends here are still wild in its praise and do not like my sending out of this State. I do not live in the narrow boundary line of section. If my State affords me no proper place to put it, then I am at liberty to select the place I like best." (14). She had written to Dr. Peck at an earlier date, "I confess to much diffidence in making a presentation of my work, fearing I have made some blunders. In my heart it is the most treasured volume I possess. It is this which prompts me to place it in a scientific institution where it will be preserved. It is the work of nearly twenty years, begun under the greatest of difficulties, without books, but pursued with the most untiring zeal." (15).

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11. From the preface of "The Fungi of Maryland".
12. Letter from Banning to Peck 24 April 1889. From the collections of the New York State Museum.
13. Letter from Banning to Peck 15 March 1890. From the collections of the New York State Museum.
14. Letter from Banning to Peck 19 March 1990.

She had extracted a promise from Dr. Peck that if he did not think the volume desirable he would return it at her expense; that his opinion was entirely the reverse is shown in her letter to Dr. Peck of 28 March 1890 in which, he says "I am very much pleased with your favorable opinion of the illustrated volume. I think it a great compliment to hear you compare the drawings favorably with Fries' 'Icones Hymenomycetes'.... I am most happy that you like and appreciate my work." (16)

In 1890 she wrote to Dr. Peck, "The presentation of my book to the New York Museum has brought down many dissenting voices among my friends in Maryland. Some think I ought to have sold it to some institution in the State for a large price, or given it to the Johns Hopkins University or the Peabody Library. I did not make the gift without mature deliberation and reflection. To offer the book for sale (and neither of the above named institutions was able to purchase) I could not honestly do, without being able to certify that all the plants given were rightly determined. The work was well done, the figures true to life, but the determination of plants as you well know requires the knowledge of a expert in mycology. This I am not, as I am yet in the leading-strings. If the book was to be given to the State, then let the State prepare a proper place for it. I believe I am the pioneer of fungi in Maryland, as I know of no one outside the District who has engaged in the difficult study." (17)

On 16 February 1887 Miss Banning had written to Professor W. G. Farlow, of Harvard University: "My illustrated book of Maryland fungi is greatly enlarged since you saw it. It will never be published because of the expense. I shall give it to the Johns Hopkins University where I think it will be of some use to those who study mycology."

On 25 February 1887 she wrote to Professor Farlow: "I posses a ponderous book of illustrations that is perfectly worthless financially; but I flatter myself it may be of some use to an institution of learning such as Johns Hopkins University. The chief merit is in showing what plants are to be found in Maryland. Apart from this I even feel a diffidence in presenting it."

It has been shown how her plans were changed as to the ultimate home of her "book". However, the manuscript has been copied in typewriting so that the text is available in my library for those who care to see it, although the interesting illustrations are lost to Maryland.

Dr. Peck wrote of Miss Banning's volume, "which she has most generously donated", in the 44th Report of the New York State Museum, 1892, 176-187; in the same report he printed her catalog of Maryland fungi.

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15. Letter from Banning to Peck 24 April 1989. In collections of the New York State Museum.
16. Letter from Banning to Peck 28 March 1890. In collections of the New York State Museum.
17. Letter from Banning to Peck 22 May 1890. In collections of the New York State Museum.

There is a gap in letters from 1880 to 1887, when she seems to have lapsed in correspondence. During this time she met with a great sorrow in the death of her beloved sister, Catherine, on 13 April 1885. Her gravestone in St John's churchyard, Waverly, now a part of Baltimore, bears the simple legend "Catherine Fountleroy Banning entered into rest" and after the date the words "Blessed are the pure in heart".

However her interest in fungi suffered little interruption and in one of her letters she says: "Both in Maryland and Virginia I get no help in the way of finding plants. The idea of looking for 'Frogstools' is burlesqued so far as they dare to do so. There is no sympathy for the work, in fact they regard it as ridiculous. All this has not the slightest effect upon me, save in retarding my progress in the work. I hire a carriage, wagon, or any sort of vehicle I can get, start off to do good work, but they regard me as a crazy woman, fit to be placed in a straight jacket. Is it not laughable! How I do pity their ignorance. Were I to tell them this they would regard it one more evidence of my insanity." (18)

Miss Banning's relatives, several of whom live in Baltimore, speak of the reserve which is so noticeable in her letters as a predominant trait. They speak of her high ideals, her charity, and always of her delight in nature. She loved music and flowers which she pressed, and cared a great deal for animals of which she made little sketches with indelible ink on the table linen, bed linen and towels. A curious pastime was dissecting fish, and after wiring the bones, putting them together again.

In the spring of 1890 she went to Winchester, Virginia, and boarded with the family of Mr. T. T. Wall. She speaks of "This boarding-house life even under the most pleasant of circumstances, as it is certainly here, is a constant jostle--an upheaval if I may so call it of all the elements contained in humanity. It is certainly much better adapted to the study of human nature than to the arts and sciences." (19)

She probably left Winchester in 1891 but returned there in the summer and made it her home. She speaks of Mr. and Mrs. Wall as "very nice reliable people. Very kind on all occasions."

Miss Banning was a pleasant letter-writer, and her letters not only contained interesting information on fungi but have frequent humorous touches and often show personal charm. Thirty seven letters (1879-1897) to Professor Peck are on file at the New York State Museum; these I had copied through the courtesy of Dr. H. D. House, State Botanist, and I have placed them in my library; I have, also, four letters (1879-1887) to Professor Farlow which he kindly had copied for me.

She suffered from dyspepsia, and for weeks at a time took no solid food, but seemed to improve in Winchester where she was much in the open air and drank "the lime and sulphur waters". In 1891 she had a bad attack of grippe, epidemic in Winchester, from which she was a long time recovering. In 1894 she was again ill, but writes "I am never too sick to take an interest in fungi and flowers. I wish I had given my whole life up to that

18. Letter from Banning to Peck 7 May 1889. In collections of the New York State Museum.
19. Letter from Banning to Peck, undated. In collections of the New York State Museum.

study. I believe I should now be an expert in every department, but home duties occupied my time in early days and perhaps I am not right in feeling a regret. I had rather die with the feeling of having done my duty than die with the feeling of having gratified an undying love for botany. Both were before me, but I took the duty that God placed before me. I think I am, have been, right. I am never too sick to take an interest in flowers and fungi." (20)

In 1897 she was a sufferer from rheumatism and writes "I shall never be able to collect as I once did". She was now in her seventy-fifth year and, not able to go about as she once did, felt a great longing to see her beloved "book". She writes to Dr. Peck (1 March 1897): "I hardly know how I ever came to part with my illustrated book....it would be such a source of pleasure to me. My giving it out of my State has I know been thought hardly of by my friends. I would like to know if it has been of any use to you in New York. Nearly all are Maryland plants. If it is of any use then I could pardon myself for giving it away, if not thus it would be a lifetime regret. I wish you would tell me something about its usefulness. I suppose it is in a good state of preservation. It afforded me so many happy hours that it lingers in my memory -- to tell the truth I often long to see it and call it my own once more, but this could not be" (21). What a pathetic appeal from a tender-hearted woman for a dear absent child, who, she knows, will never be restored to her!

Miss Banning's latter days were clouded by anxieties arising from the infirmities of age, and the difficulties of living on a very small income. She lived in Winchester, Va. in a boarding house, where she was able to pay but $5 a week, and was surrounded by a noisy class of people who were very distasteful to her.

She had no intimate personal friends whom she cared to have visit her so that she was left vet much alone to fret over financial matters. From 1896 to 1902 she grew steadily more infirm, and as her letters show, her handwriting, usually clear and bold, took on the crabbed tremulous character of old age. Her mind remained clear to the end. She had anticipated a much earlier death, and deliberately made all the detailed plans for the transportation of her body to Baltimore where she desired her executor to lay her in the same grave with her sister in St. John's churchyard. She wished to have no notice of her death in the Baltimore papers unless she died in Baltimore, "but if I die in Baltimore I beg you to write the notice of my death as follows: "Departed this life on --------- Mary E. Banning." I specially desire that nothing more be said.

I wish no invitations given to my funeral except to my old nurse Dolly Denny (colored), and to Clementina Gladden (colored)". She further says, "If I make no disposition of my book on the "Maryland Fungi" before my death, it will go to the "New York Museum of Natural History". My friend Prof. Charles H. Peck of Albany is a member of the Museum staff, and the State Botanist. Any communication with him will be understood as he knows it is my intention (if I make no other disposition of it during my

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20. Letter from Banning to Peck 25 July 1894. In collections of the New York State Museum.
21. Letter from Banning to Peck 1 March 1897. In collections of the New York State Museum.

lifetime) to give it to the New York State Museum at my death."

Her sense of honor and integrity led her to waste no little time in anxiety over her annuity, fearing she might be living too long and so receiving more than the calculated amount from the insurance company. No one ever looked forward with more eagerness to death as a release from the cares of a distressed lonely life.

She died in Winchester on February 28, 1903, and her wishes were faithfully carried out by her friend and executor Mr. George H. Sergeant, of Baltimore. By will she left a sum of money to St. John's Church suggesting its use for St. John's Orphanage for Boys and her books were bequeathed to her nephew Mr. James Latimer Banning of Wilmington. What would be of special interest, could they be located, would be the letters received from her distinguished correspondents and other papers relating to this talented, courageous woman who was, as she said of herself, "the pioneer of fungi in Maryland."

The Mediterranean Gecko (*Hemidactylus turcicus*) In Baltimore, Maryland

Arnold W. Norden and Beth B. Norden

During the summer of 1974 we were asked to identify a lizard found in a residence on the fourteen-hundred block of Andre Street, in south Baltimore. The lizard, a freshly squashed female Mediterranean gecko carrying two eggs, had been found in packing material included in a box of lamp shades shipped from Spain. The homeowner told us that several others had been seen, but escaped. After being assured that they were absolutely harmless, he agreed to try and capture the others in a less aggressive manner and give them to us. However, no more were seen that summer and we forgot all about *Hemidactylus turcicus*.

Mediterranean geckos again came to mind on August 23, 1976, when we were shown a juvenile specimen found in another residence a short distance from the first. Since this individual documented survival and reproduction it was preserved and placed in the collection of the Natural History Society of Maryland (R-2016-NHSM). Its occurrence in another residence was not in the least surprising since these were contiguous row-homes. Since then, these interesting lizards have been regularly observed in this area, confirming that the Mediterranean gecko is well established in this region of south Baltimore.

Unfortunately, it is difficult to determine how far this population has spread from its original point of introduction. Home owners in this area of the city are understandably proud of their meticulously clean houses, and the presence of lizards is not something that they talk about easily. Still we know that *Hemidactylus* is of common occurrence at least throughout much of the fourteen hundred block of Andre Street. Since this is an area of closely spaced blocks of row houses, geckos would have little difficulty moving around and should eventually spread throughout this and adjacent areas of the city.

During the summer of 1990, residents of Andre Street placed "sticky-tape" strips on the small deciduous trees in front of their houses to protect against gypsy moths. On June 19th we examined these tapes and noted one adult and one juvenile lizard stuck securely, along with broken tails from five other individuals. We do not know if these geckos moved onto these tapes by accident, or were attracted to the numerous insects that were also trapped, but the presence of such a large number indicates that a large population of Mediterranean gecko's is resident.

Hemidactylus turcicus is an Old World species that originally occurred around the Mediterranean Basin. However, it is remarkably adept at getting itself moved around with our baggage, and has been introduced into numerous new locations throughout the world. In North America it is now known to occur at over a dozen localities along the Gulf Coast in Florida, Louisiana and Texas (Conant 1975, McCoy 1970). However, its spread northward has been less successful, and this Maryland population is the only one known in

North America above the level of north-eastern Texas. Undoubtedly, its successful introduction into the Baltimore area is due to the presence of large blocks of row homes that provide warm and secure habitat during the winter.

We would like to thank Mrs. Lydia Norden for keeping us informed of the status of *H. turcicus* in Baltimore. Mrs. Norden has reported numerous sightings to us over the past fifteen years. She also obtained several live specimens for us, including the individual shown in Figure 1.

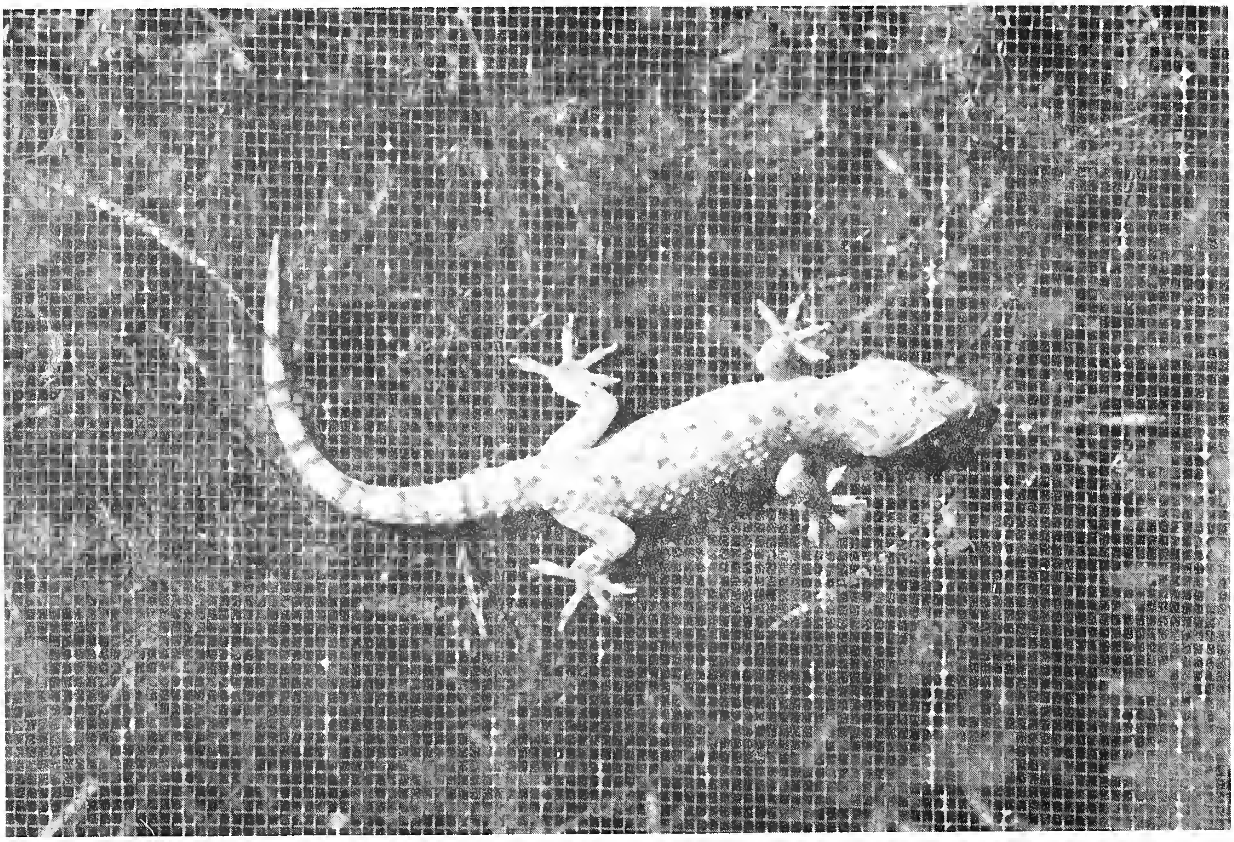

Figure 1. Adult male *Hemidactylus turcicus* collected in Baltimore during the summer of 1989, 4.5 inches (115 mm) in total length.

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(AWN) Natural History Society of Maryland, 2643 North Charles Street, Baltimore, Maryland 21218; (BBN) Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560.

First Records for the Leatherback Turtle (*Dermochelys coriacea*) Along Maryland's Atlantic Coast

Eugene J. Scarpulla

The leatherback turtle has long been known from Maryland waters, in fact the first leatherback reported from the United States was from the Chesapeake Bay (Carr 1952, Groves 1984). However, although there are now four reports for this species from within the Bay (Hardy 1969, Harris 1975), it has not previously been reported from along Maryland's Atlantic Coast (Groves 1984).

On 30 June 1982, William F. Wilke and I sighted an adult leatherback turtle off the coast of Worcester County. At the time we were aboard Wilke's boat, the *Sea Shelly*, returning from a trip to the Isle of Wight Shoal, which is located 12.9 kilometers (8 miles) offshore of Ocean City, Maryland (Figure 1). The turtle was first observed at about 1400 hours, approximately 9.7 kilometers (6 miles) from shore. It was of large size and we estimated its total length to be 1.83 meters (6 feet). The head, carapace, and flippers were black, but the head had numerous white blotches. The keeled, leathery carapace was clearly observed.

On 12 August 1982, Wilke, along with Carol W. Angel and Karen A. Locke, observed a second leatherback near Isle of Wight Shoal. That individual was smaller than the first, and had an estimated length of 1.2 meters (4 feet). It was kept under observation for about 15 minutes, during which the characteristic leathery carapace was readily apparent.

It is interesting that, although other sea turtles have been observed by us on numerous occasions during offshore trips throughout this area, *Dermochelys* has only been noted in the vicinity of Isle of White Shoal. The shoal itself is a pronounced mount on the Continental Shelf that rises to within 5.9 meters (about 19.5 feet) of the surface, providing a notable shallow area in otherwise deeper coastal waters. The actual water depth where these two individuals were observed was 16. 5 meters (about 54.0 feet) for the 12 August 1982 sighting and 10.1 meters (about 33 feet) for the 30 June 1982 sighting.

With Atlantic Seabirds continuing Ocean City, Maryland trips for seabirds, marine mammals and sea turtles, additional sightings of leatherbacks and other marine turtles are expected. These will be reported in future issues of this journal.

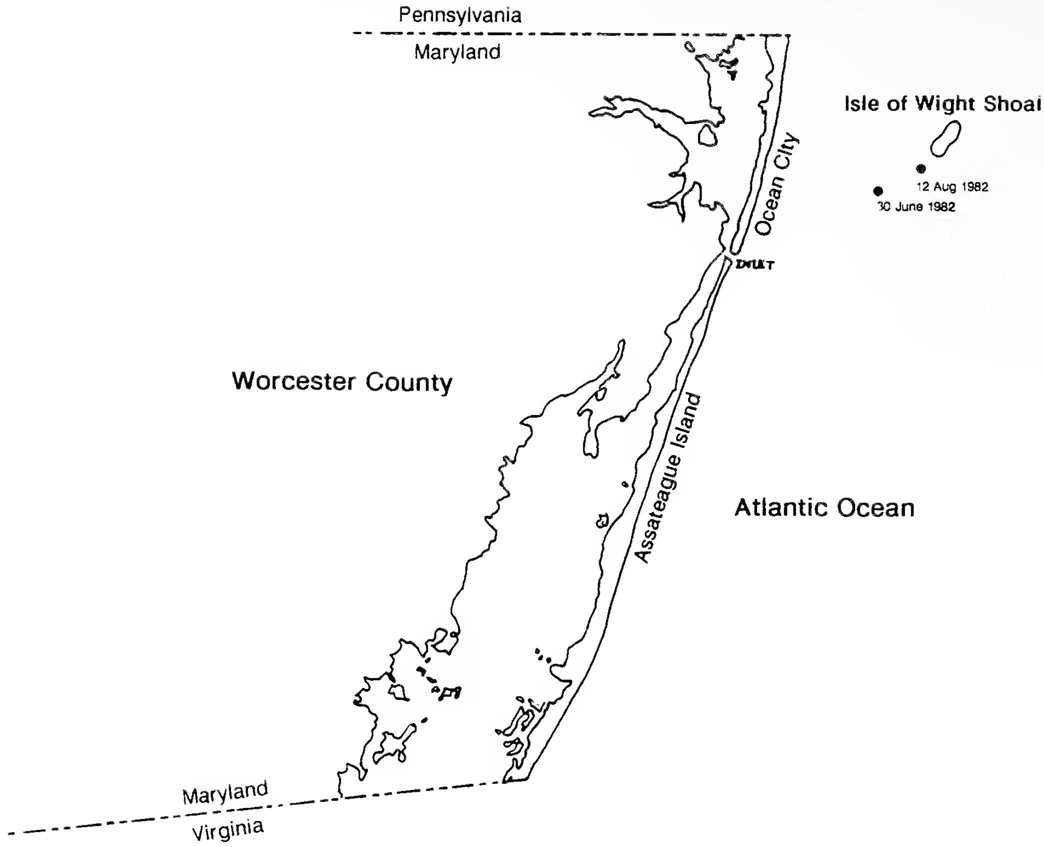

Figure 1. Atlantic Coast of Maryland showing location of leatherback turtle sightings in the vicinity of Isle of Wight Shoal.

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Atlantic Seabirds, 7906-B Knollwood Road,
Towson, Maryland 21204

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Manuscripts submitted for consideration should be typed, double spaced, on good quality bond paper with adequate margins. Authors should adhere generally to the *Council of Biology Editors Style Manual*. However, individuality and readability of writing style are encouraged.

Contributions other than short notes may include a brief informative abstract. Payment of page charges is not required for publication in *The Maryland Naturalist*. However, if funds are available, assistance to offset publication costs would be welcome.

Subscription to *The Maryland Naturalist* comes with membership in the Natural History Society of Maryland.

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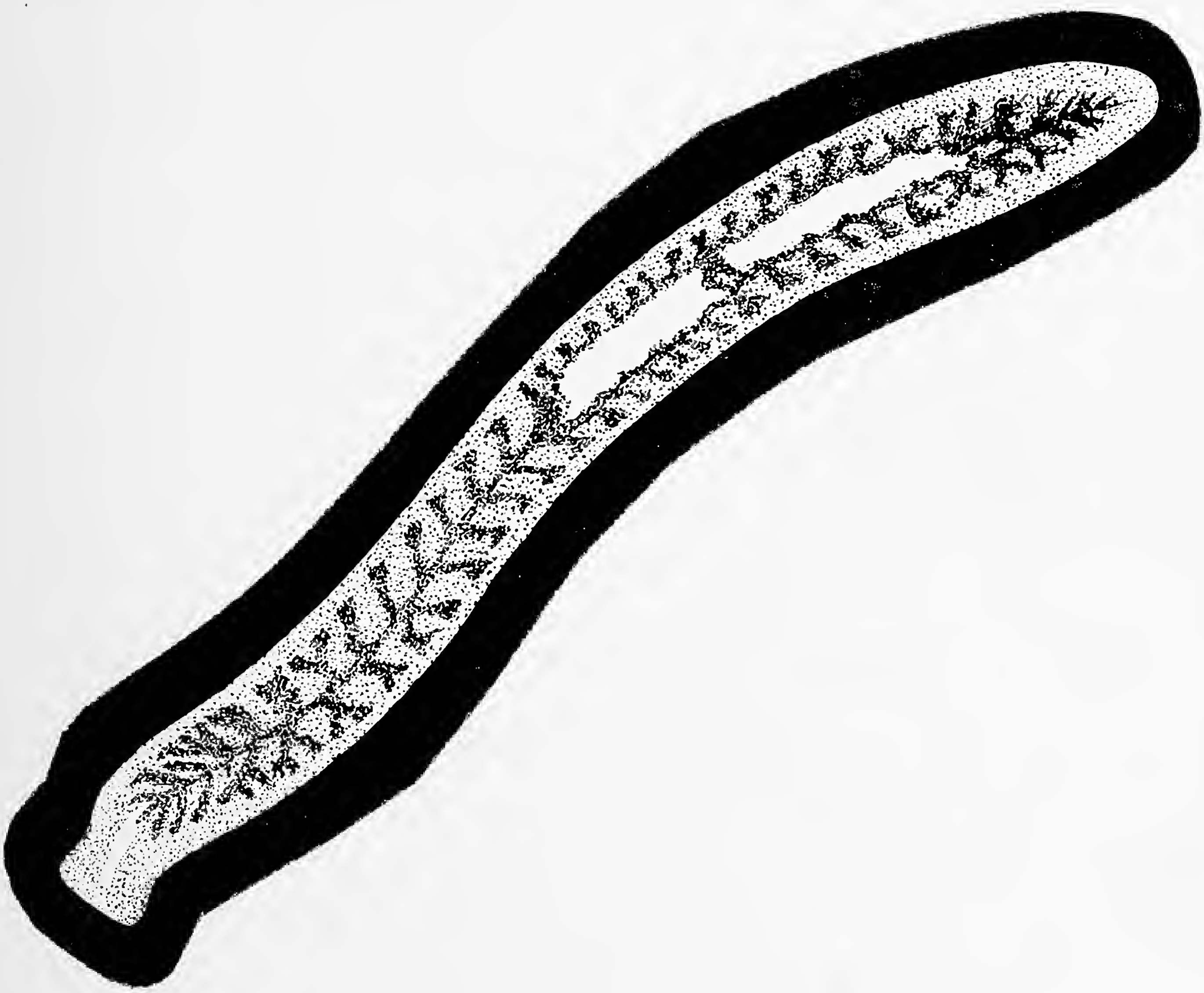

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Arnold W. Norden, Editor

Mailing Date: 1 March 1992

Cover Illustration: *Procotyla typhlops*, a very rare groundwater inhabiting planarian has been reported from two localities in Florida, two localities in Virginia, and one locality in western Maryland. Although found in surface seepage areas and springs, this eyeless, unpigmented species has never been found in caves. This is an original drawing by Josephine B. Thoms from a color transparency by Roman Kenk.

The Distribution of Freshwater Triclad Planarians in Maryland

Arnold W. Norden, Beth B. Norden
Aubrey G. Scarbrough

Introduction

In the early 1970's two of us (AWN, BBN) began making incidental collections of freshwater triclad planarians in Maryland. To our surprise, most of these represented significant extensions of known species ranges, including several first records for this state or region. Consequently, we decided to conduct a more extensive survey of Maryland's planarian fauna to determine which species occurred here, and how they were distributed within the state. We also sought to gather basic ecological data for each species. That study resulted in a M.S. thesis submitted to the faculty of Towson State University in 1978 by AWN. Data from the original study, augmented by subsequent collections, is presented here.

Methods

In order to obtain all species and establish a realistic concept of their distribution, collections were made throughout the state in all habitat types. In addition, field work in all regions was conducted during cold as well as warm months of the year so that species of seasonal occurrence would be obtained. Each locality visited was examined for twenty minutes by one person. Planarians were considered absent if none were encountered within that time. When found, specimens of each type present were collected for identification and determination of their reproductive condition.

The most effective way to locate planarians was found to be direct examination of the substrate. Since all freshwater triclads avoid sunlight they spend daylight hours concealed in dark places and can be found beneath stones, sticks, leaves and other cover. They also occur frequently in leaf axils of emergent plants such as *Sparganium* and *Typha*, and in masses of floating or submerged vegetation. Trapping, which has been found to be very effective by others (Kenk 1972), was not used extensively in this study because we found it to be more time consuming than substrate examination but no more effective.

Since most planarians found in Maryland have a characteristic external appearance (Figure l), identification was generally done by observing, under 10X magnification, healthy specimens freely gliding in a small amount of cool water. However, some local species cannot be positively identified by external appearance alone, and must be sectioned for internal examination. Specimens selected for internal examination were fixed in a hot solution of mercuric chloride, serially sectioned at eight microns, stained with Ehrlich's acid hematoxylin and eosin-phloxine B, and permanently mounted on glass slides, as recommended by Kenk (1972). Selected series of each species found were deposited in the invertebrate collection of the Museum of Natural History, Smithsonian Institution.

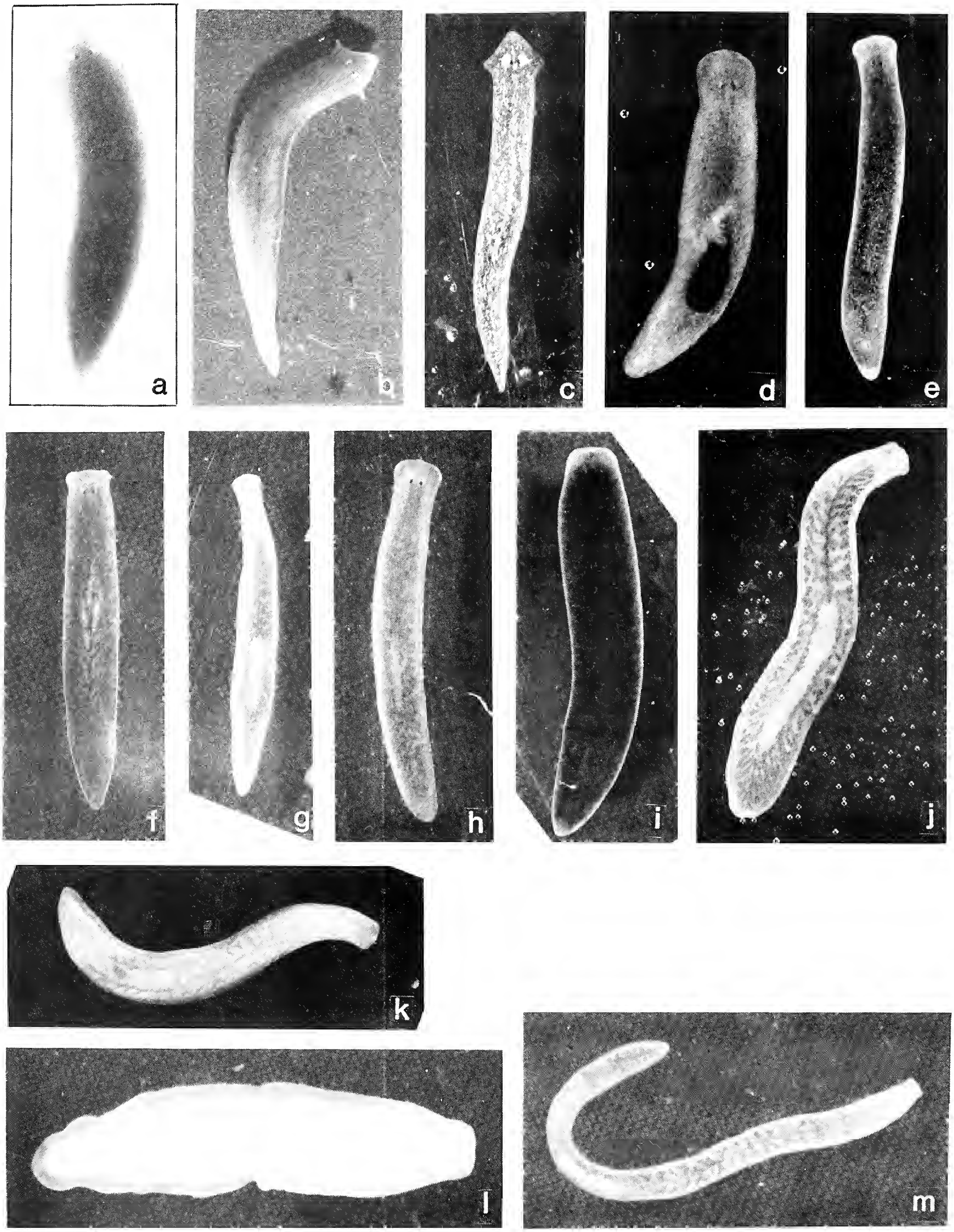

Figure 1. External appearance of freshwater triclad planarians known to occur in Maryland: a, *Cura foremanii*; b, *Dugesia dorotocephala*; c, *Dugesia tigrina*; d, *Hymanella retenuova*; e, *Paraplanaria dactyligera*; f, *Phagocata gracilis*; g, *Phagocata morgani*; h, *Phagocata velata*; i, *Phagocata virilis*; j, *Procotyla fluviatilis*; k, *Procotyla typhlops*; l, *Sphalloplana hoffmasteri*; m, *Sphalloplana* sp. *Phagocata woodworthi* is externally identical to *P. gracilis* (f). All photographs are of healthy, adult individuals collected in Maryland. Not to scale.

To acquire basic ecological data for each species, we determined water temperature, dissolved oxygen, dissolved carbon dioxide, pH, calcium hardness and alkalinity at the time and place of each collection. The water chemistry measurements were made with commercially available test kits (LaMotte Chemical Company, Cambridge, Maryland) using standard methods. In addition, various other features of the habitat that might prove significant (width and depth, aquatic vegetation, pollution sources, substrate type, current velocity, etc.) were recorded. We also used topographic maps to classify streams to order according to the system of Strahler (1954, 1957).

The nomenclature used here follows Kenk (1989). All distributional data has been deposited in the files prepared by Roman Kenk at the Division of Invertebrate Zoology, Museum of Natural History, Smithsonian Institution.

Study Area

Freshwater triclad planarians are creatures of low vagility that seem to disperse entirely through freshwater corridors (Ball 1971, Ball and Fernando 1970, Reynoldson 1966). The following description of the study area, the entire state of Maryland, is oriented toward dispersal corridors and environmental features affecting aquatic habitats.

The freshwaters of Maryland include tributaries of three major drainage basins and a series of small independent drainages that flow into the Atlantic Ocean from the Delmarva Peninsula (Figure 2). Of these major drainages, the Susquehanna and the Potomac flow into the Atlantic while the Youghiogheny flows into the Gulf of Mexico via the Ohio and Mississippi Rivers. There is good biological and geological evidence for faunal exchange between these three drainages by the interdigitation of headwater streams (Potomac to Youghiogheny- Ross 1952, Thompson 1939; Youghiogheny to Susquehanna- Hocutt et al. 1978, Thompson 1939), and with other drainages located to the south (Greenbriar to Monongahela to Potomac- Lachner and Jenkins 1971, Ross 1952, Schwartz 1965) and to the north (Susquehanna to Great Lakes- Hubbs and Lagler 1958). The evidence for, and history of these various stream captures is complex and additional insights are given by Ortmann (1913), Lee (1976b) and Stauffer et al. (1978).

Maryland can be divided into several physiographic regions. Because of variations in geology, these regions typically differ in topography, surface and groundwater drainage characteristics, water chemistry, and to some extent climate. These differences can be significant enough to affect the distribution of plants and animals. The following brief description of the study area is based on these physiographic divisions, as delineated by Vokes (1957).

Atlantic Coastal Plain

The Atlantic Coastal Plain (Figure 2) is an extensive region of unconsolidated sediments and localized areas of soft sedimentary rock. There is usually only modest topographic relief and the streams frequently have low gradients and sluggish flow. The lower portions of major tributaries are tidal and may be heavily influenced by saline conditions. Large stones are absent except for isolated areas where cobbles and boulders occur in ancient river deposits, areas of ironstone formation, or where artificially placed to impede erosion along ditches or at culverts.

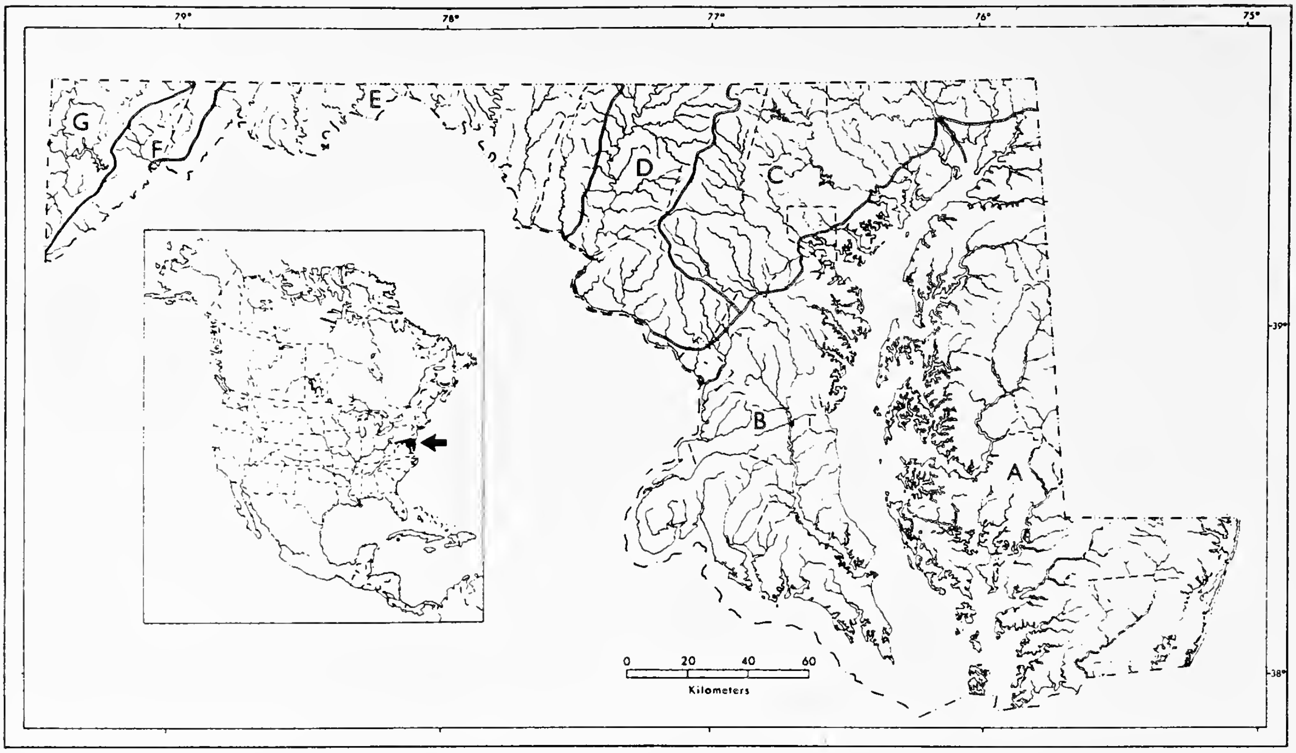

Figure 2. Map of Maryland showing major drainage features and physiographic provinces. A, Eastern Division of Atlantic Coastal Plain; B, Western Division of Atlantic Coastal Plain; C, Eastern Division of Piedmont Province (Chesapeake Bay Drainage); D, Western Division of Piedmont Province (Potomac Drainage); E, Blue Ridge, Ridge and Valley, Great Valley; F, Atlantic Slope Drainage of Appalachian Plateau; G, Ohio River Drainage of Appalachian Plateau. After Lee et al. (1981).

Seepage areas are plentiful and the presence of localized clay lenses results in numerous vernal pools. Aquatic vegetation is abundant. The banks of larger streams are often forested, but the banks of many tributaries have been cleared for agricultural use or by channelization practices. In these areas, excessive sedimentation is a serious problem and natural aquatic habitats have been significantly modified. Many streams exhibit the characteristic dark color caused by dissolved plant substances.

Much of the flora and fauna of the Coastal Plain is typical of more southerly areas (Brown and Brown 1984, Harris 1975, Lee 1987, Lee et al. 1981) and the strong resemblance of the Pocomoke River Swamp to the Dismal Swamp of southern Virginia has been noted (Beaven and Oosting 1939). Although part of the same land mass, and separated only by the Chesapeake Bay which is of recent origin, the eastern and western divisions of the Coastal Plain exhibit some significant biogeographic differences. In fact, it has been shown that eastern shore populations of several fishes (Lee et al. 1981), amphibians and reptiles (Harris 1975), and mammals (Lee 1987, Paradisio 1969) are more closely related to those on the southeastern Coastal Plain of Virginia, than those on the western shore of the Chesapeake Bay.

Piedmont Province

The Piedmont Province extends from the western edge of the Coastal Plain (Fall Line), west to the eastern slope of the Catoctin Mountains (Figure 2). It is characterized by rolling topography and numerous streams with sand and rock substrates. Gradients are frequently steeper than on the Coastal Plain and springs are common. Much of the lowland portion of this region has been deforested for agriculture or development. A natural divide runs through this province (Figure 2), with all streams to the east running directly into the Chesapeake Bay and those to the west running first into the Potomac River.

The eastern half of the Piedmont is underlain by a complex sequence of metamorphic rocks including gneiss, slate, marble, phyllites, schists, serpentine and granite (Vokes 1957). The western half is similar but some limestones, siltstones, shales and sandstones make their appearance. Submerged aquatic vegetation is locally abundant.

Blue Ridge, Great Valley, Ridge and Valley

Some authors separate these regions on geologic (Vokes 1957) or zoogeographic grounds (Harris 1975). However, since they are generally similar geologically and ecologically, and since significant barriers to aquatic dispersal are absent, we have grouped them together. Typically, they are characterized by steep sided, northeast running ridges separated by valleys, some of which are quite broad. The streams have sand and rock substrates, and those draining the slopes have steep gradients but converge to form low gradient tributaries of the Potomac River. The steep upper portions of most ridges are still forested but the lower slopes and valley bottoms have largely been cleared for agriculture or development. Submerged aquatic vegetation is locally abundant.

The major ridge making elements in this region are sandstones or quartzites, and the valleys are floored with rhyolites or basalts in the east and shales or limestones farther west (Vokes 1957). In the limestone and basalt strata caves are common and several support troglobitic invertebrate faunas (Franz and Slifer 1971). Springs are abundant in this area and many have sustained, high volume flows. Some limestone areas have predominantly vertical drainage and generally lack permanent surface streams.

Appalachian Plateau

The Appalachian Plateau includes all of Garrett County and the portion of Allegany County that lies west of Dans Mountain (Figure 2). It is a broad plateau dissected by stream valleys and bearing four ridges running in a northeasterly direction. The eastern edge of the plateau, the crest of Dans Mountain, drops off to form a steep escarpment known as the Allegany Front. As with the previous regions, the streams have clear, uncolored water, steep gradients where they drain slopes, and low gradients where they converge on the plateau. Springs are common and interesting marshy meadows called glades occur at the headwaters of many streams.

This region is underlain by a complex sequence of shales, siltstones, limestones, and sandstones interbedded with coal seams. Much of the coal is accessible and acid mine drainage due to strip and deep mining activity is a major problem. Several significant caves are present in limestone areas.

The Appalachian Plateau can be divided into two divisions (Figure 2) to stress the importance of the ridge formed by Backbone and Meadow Mountains, which is a major divide between the Atlantic and Gulf Drainages. All streams east of this divide flow into the Potomac River then to the Atlantic Ocean, while those to the west flow to the Gulf of Mexico via the Ohio and Mississippi Rivers. Several aquatic species typical of the Ohio River drainage enter Maryland only in this area, and numerous other animals and plants occur in Maryland only on this plateau. This is partly due to the Ohio drainage influence and partly due to the presence of relict communities of boreal species typical of more northern areas. Further discussion of the biogeography of this region has been given by Lee (1976a).

Species Accounts

Cura foremanii (Girard 1852)

Description

This is one of three Maryland planarians that exhibit the combination of eyes, dark body pigment, and a triangular shaped anterior end (Figure 1). It differs from the other two (*Dugesia dorotocephala* and *D. tigrina*) in being broader, with a more blunt anterior margin, and lacking prominent auricles ("ears"). Maryland specimens ranged up to 14 mm in length.

Maryland Distribution

Cura foremanii was found at 43 localities. It was generally distributed and fairly common on the Coastal Plain and Piedmont Province, with a few scattered populations to the west (Figure 3). *Cura* was not found on the Appalachian Plateau.

Ecology

Cura foremanii was found only in running water where it occurred in Order one streams nine times (20.9%), Order two streams 19 times (44.2%), Order three streams 13 times (30.2%), and Order four streams twice (4.7%). Widths and depths of these streams ranged from 0.3 m X 1.0 cm to 7.0 m X 15.0 cm. Substrates were variable but typically included stones ranging from pebble to boulder size. At most Coastal Plain locations they were found in the axils of *Sparganium* leaves.

Kenk (1944) described *C. foremanii* as "a typical inhabitant of small creeks and rivers that do not warm up very much in summer. Cold springs, warm rivers, and stagnant water are apparently not suitable. Therefore, as a rule, it is not found in streams that drain shallow lakes." That description was supported by the findings of Givens (1953), Chandler (1966), Longest

(1966), Darlington and Chandler (1972), and is consistent with our study. Chandler (1966) found *C. foremanii* to be more eurythermal than *D. tigrina* or *D. dorotocephala* in the laboratory and suggested that higher temperatures may affect its distribution by reducing its reproductive capacity.

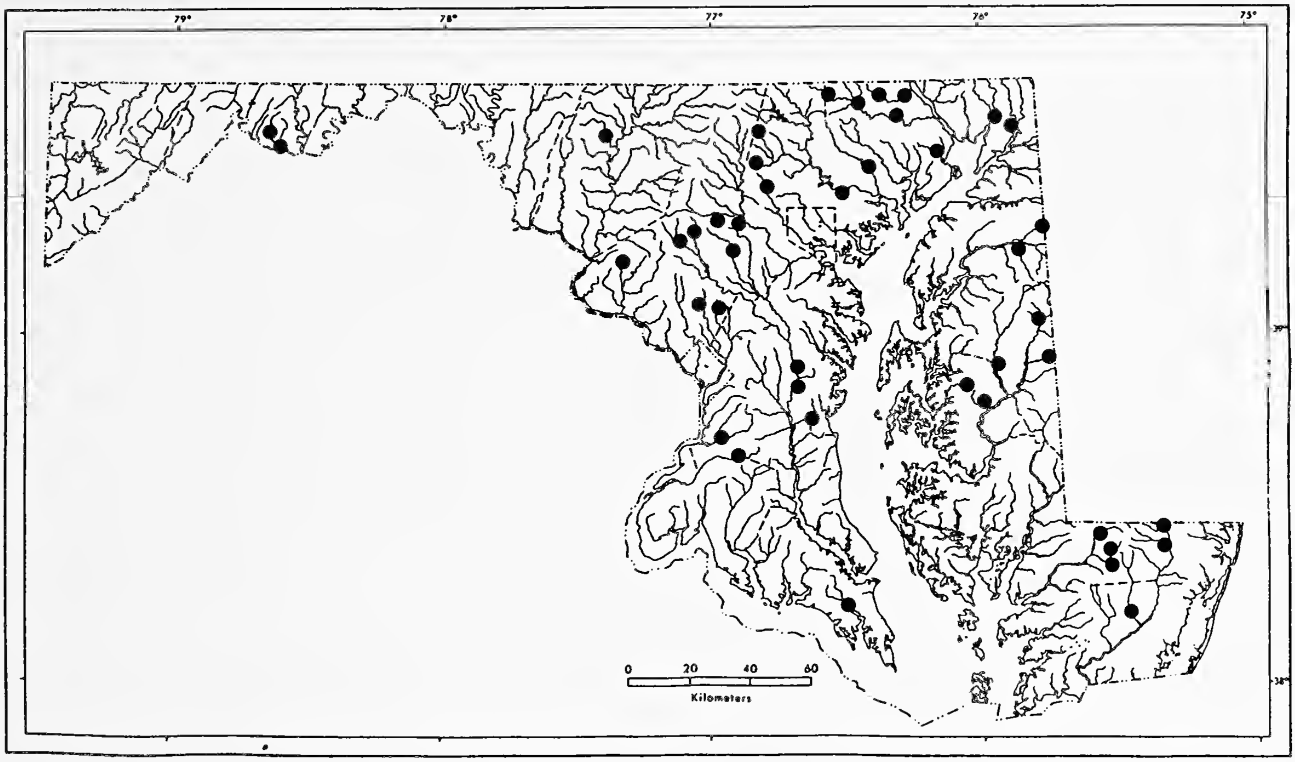

Figure 3. Known localities for *Cura foremanii* (•) in Maryland.

Sexually mature *C. foremanii* were found in Maryland throughout the year and cocoons were observed in June, July, September and October. At one locality, both cocoons and newly hatched young were present on October 18, and several cocoons that were collected hatched while being transported back to the laboratory.

One population of *C. foremanii* from Caroline County included many individuals without heads. Roman Kenk (personal communication) kept some of those individuals in culture and found that they subsequently grew normal anterior ends only to lose them again, while remaining sexually mature. This condition was not observed elsewhere and nothing similar has been reported in the literature.

Temperature and selected water chemistry parameters obtained from 63 data collections for *C. foremanii* are given in Table 4.

General Distribution

Cura foremanii ranges over the eastern half of North America where it has been reported

from Arkansas, District of Columbia, Illinois, Indiana, Louisiana, Maine, Massachusetts, Michigan, North Carolina, New Brunswick, New York, Ontario, Pennsylvania, Quebec, Rhode Island, Tennessee, and Virginia (Ball 1969; Ball and Fernando 1970; Chandler 1966; Darlington and Chandler 1972, 1979; Givens 1953; Hyman 1931; Kenk 1935, 1944, 1972, 1989; Longest 1966; Whitehead 1965). In addition, we have collected *C. foremanii* in Delaware and Florida. Kenk's (1944) previous record for Maryland was based on Girard's (1852) record for the District of Columbia (personal communication).

Dugesia dorotocephala (Woodworth 1897)

Description

This is an eyed, pigmented planarian with a triangular head and thin, pointed auricles (Figure 1). The only local species that could be confused with it are *C. foremanii* and *D. tigrina*, which have shorter, blunter auricles. *Dugesia dorotocephala* is one of the largest planarians in North America and Maryland specimens ranged up to 33 mm in length.

Maryland Distribution

Dugesia dorotocephala was found at 21 localities distributed from the eastern edge of the Piedmont west to the Ridge and Valley Region (Figure 4). It was not found on the Coastal Plain or the Appalachian Plateau.

Ecology

This large species was found only in running water where it occurred in Order one streams five times (23.8%), Order two streams six times (28.6%), Order three streams five times (23.8%), Order four streams twice (9.5%), Order five streams twice (4.8%), and higher order streams twice (9.5%). One of the higher order streams was the Susquehanna River below Conowingo Dam. The river is about 150 m wide at that point but the planarians were found in shallow pools along the bank and may not have been present in the mainstream. Of the other localities, one was a large spring head and the rest were typical streams ranging from 0.3 m X 0.5 cm to 20.0 m X 15.0 cm.

Kenk (1944) described *D. dorotocephala* as an inhabitant of "cool, unpolluted springs, creeks, and spring-fed marshes and lakes," but other authors have reported it at temperatures as high as 27° C (Chandler and Darlington 1979, Darlington and Chandler 1972), and Chandler (1966) found that in the laboratory it acclimated well to 25° C, and did fairly well at temperatures as high as 31° C. Thus it seems that *D. dorotocephala* is a relatively eurythermal species. Speight and Chandler (1980) found that it chose a range of 27 to 34° C when placed in a temperature gradient, and noted that it was more eurythermal than *Phagocata gracilis* or *Phagocata velata*.

Fawcett (1969) found *D. dorotocephala* to be a voracious predator that attacked amphipods, oligochates, corixids, plecopteran and damselfly nymphs, beetle and mosquito larvae,

amphipods, oligochates, corixids, plecopteran and damselfly nymphs, beetle and mosquito larvae, and other planarians (*Phagocata fawcetti*). In fact, it was so successful at capturing and consuming *P. fawcetti*, that it completely eliminated it in laboratory cultures, and may have been a major reason that these two planarians were never found to occur together in the same streams during his study.

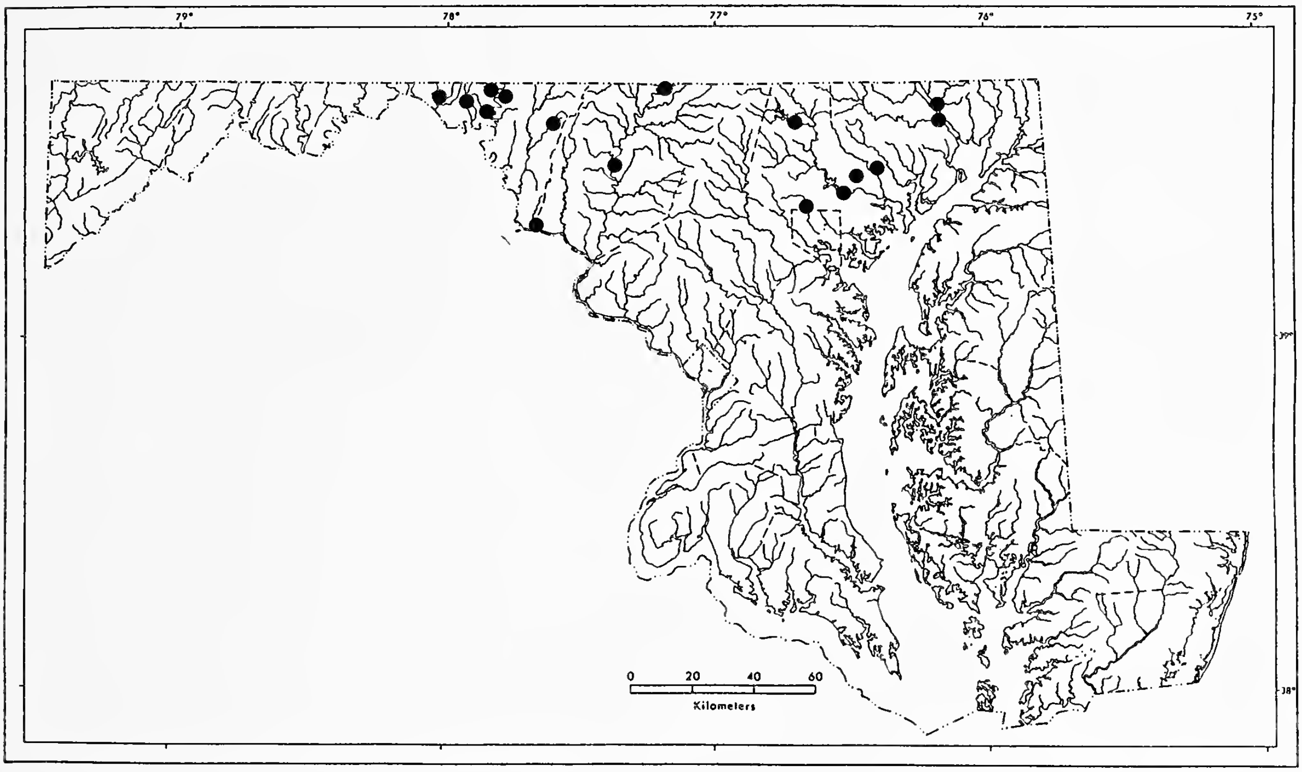

Figure 4. Known localities for *Dugesia dorotocephala* (●) in Maryland.

Temperature and selected water chemistry parameters obtained from 37 data collections for *D. dorotocephala* are given in Table 4.

General Distribution

Dugesia dorotocephala seems to range throughout the United States and into Central America. It has been reported from Arkansas, Arizona, California, Colorado, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Mexico, Michigan, Mississippi, Missouri, Montana, Nebraska, Nevada, New Mexico, Ohio, Oklahoma, Oregon, Pennsylvania, South Dakota, Tennessee, Texas, Virginia, West Virginia, Wisconsin, and Wyoming (Chandler 1966; Chandler and Darlington 1975, 1982; Darlington and Chandler 1972, 1979; Fawcett 1969; Givens 1953; Hyman 1931, 1939, 1963; Kenk 1935, 1944, 1972, and personal communication). It may also occur in Guatemala (Ball 1971).

Dugesia tigrina (Girard 1850)

Description

Dugesia tigrina is an eyed, pigmented species with a triangular head and short, pointed auricles (Figure 1). Adults are variously patterned with mottled brown splotches or a pair of longitudinal stripes separated by a light mid-dorsal streak. Hyman (1939) described and illustrated three distinct pigment patterns. We found all three in Maryland and several were commonly found in a single population. Bright green individuals were noted at several locations, apparently as a result of some ingested substance since the green color was lost after a short period in culture. Maryland specimens ranged up to 18 mm in length.

Dugesia tigrina differs from all other local planarians in exhibiting the combination of eyes, body pigment, and short pointed auricles (Figure 1). *Cura foremanii* has very blunt auricles and *D. dorotocephala* has more sharply pointed auricles.

Maryland Distribution

Dugesia tigrina is the most abundant and widespread planarian in Maryland. It was recorded at over 150 localities, including all physiographic provinces, drainages and counties (Figure 5).

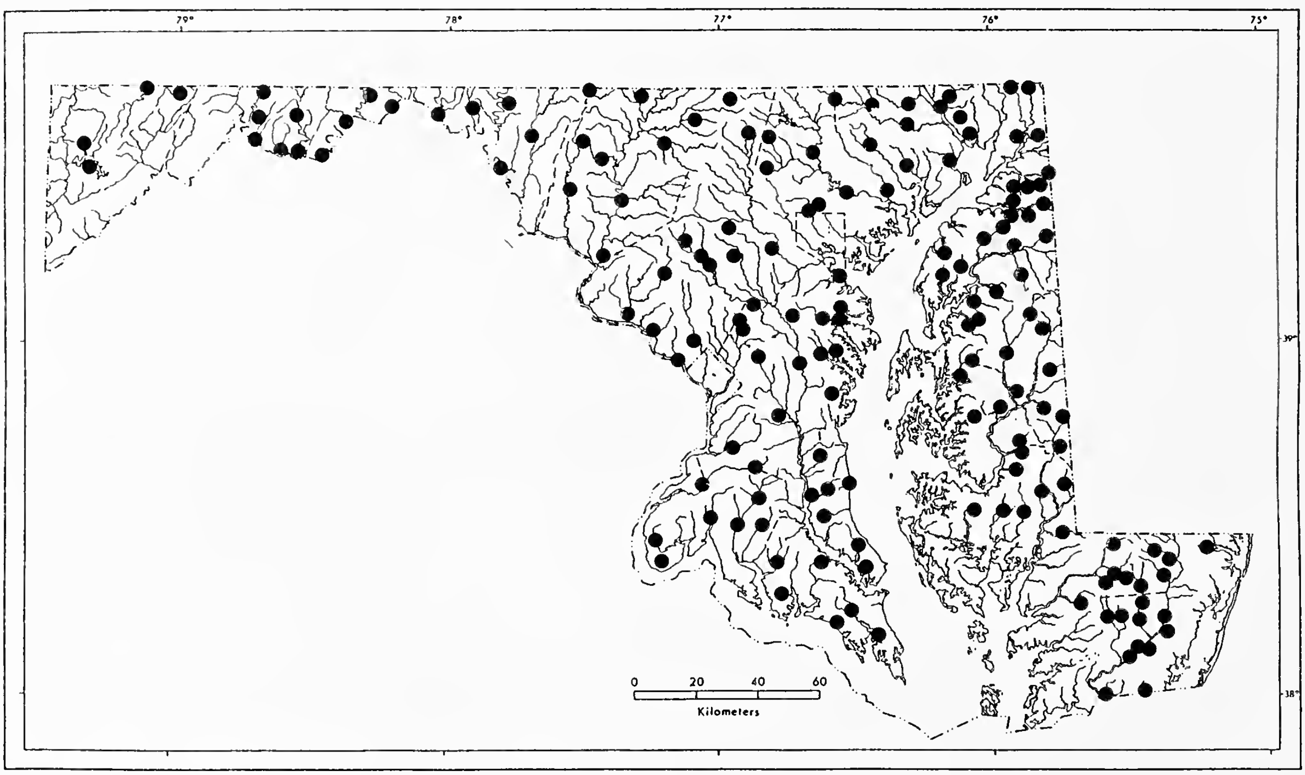

Figure 5. Known localities for *Dugesia tigrina* (●) in Maryland.

Ecology

At 154 localities where data was taken, *D. tigrina* occurred in ponds 24 times (15.6%) and in streams 129 times (84.4%). The ponds ranged from small farm ponds to large reservoirs. In running water, it was found 13 times in Order one streams (8.4%), 44 times in Order two streams (28.6%), 52 times in Order three streams (33.8%), nine times in Order four streams (5.8%), 3 times in Order five streams (1.9%), once in an Order six stream (0.7%), and eight times in higher Order streams (5.2%). These streams ranged from 0.4 m to over 150 m in width. *Dugesia tigrina* was found in or on vegetation at 62 localities (41%), notably more often that any other species found in Maryland.

Rehmel (1974) examined the habitat preferences of *D. tigrina* in a swampy area of a eutrophic lake in Indiana. She found that the density of all invertebrates, including the planarians, increased with the diversity of the aquatic plant community. The greatest densities of *D. tigrina* found in her study, 377.7 and 387.3 individuals per kilogram of substrate, occurred in masses of floating algae.

Dugesia tigrina is eurythermal and we found it at a wider range of temperatures than any other local species (Table 4). Twenty of our temperature measurements were 25° C or higher, and one collection was made at 34° C. The ability of this species to tolerate such high temperatures has been noted by others, including Chandler and Darlington (1982), Dahm (1958), Stokley et al. (1965), and Whitehead (1965), who placed it as high as 25-26° C, or Abbot (1960), Chandler (1966) and Rehmel (1974) who found a maximum tolerable temperature of between 33 and 35° C. Russier and Lascomb (1970) noted that *D. tigrina* studied by them were able to survive two weeks at 37.5° C with a 65% survival rate.

At the low end of the scale, *D. tigrina* has been found to show distress, stop feeding and become inactive at temperatures between 6 and 10° C (Chandler 1966, Dahm 1955, Pickavance 1971a and b, Whitehead 1965). Rehmel (1974) found that specimens lowered to 6° C died within a few hours. Our data support these findings, and collections made by us at temperatures below 10° C were all inactive specimens. Other local species were frequently found active at temperatures below 10° C.

Populations of *D. tigrina* usually reproduce asexually by fission during the warm months and sexually in late spring, early summer and fall, although some populations remain asexual throughout the year and may never reproduce sexually (Kenk 1944). Armstrong (1964) studied an asexual population of *D. tigrina* in the laboratory and found that it regularly reproduced by fission, but cannibalized its fission pieces when the population density became high.

During the fall we occasionally found tight clusters containing hundreds of *D. tigrina*. Similar aggregations were also reported by Stokley et al. (1965) from Ohio.

Temperature and selected water chemistry parameters obtained from 223 data collections for *D. tigrina* are given in Table 4.

General Distribution

Dugesia tigrina occurs throughout North America, where it has been reported from Alberta, Arkansas, British Columbia, California, Colorado, Connecticut, Florida, Georgia, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Mexico, Michigan, Minnesota, Nebraska, New Brunswick, New Mexico, New York, North Carolina, Ohio, Oklahoma, Ontario, Oregon, Pennsylvania, Quebec, Rhode Island, South Carolina, Tennessee, Virginia, Washington, and Wisconsin (Ball 1969; Chandler 1966; Chandler and Darlington 1975; Darlington and Chandler 1972, 1979; Givens 1953; Hyman 1931, 1939, 1963; Kenk 1935, and personal communication; Longest 1966; Whitehead 1965). In addition, we have collected it in Delaware and New Jersey. It has also been reported from Brazil (Marcus 1946), and has been introduced into Europe (Dahm 1955, Pickavance 1968).

Hymanella retenuova Castle 1941

Description

This is an eyed, pigmented planarian with a gently rounded frontal margin and no prominent auricles (Figure 1). The anterior extension of the intestine in this species usually ends before reaching the level of the eyes. In the other three pigmented, monopharyngeal planarians that occur in this area (*Paraplanaria dactyligera*, *Phagocata velata*, and *Phagocata virilis*) the intestine typically extends to or beyond the level of the eyes. This difference is easily observed in *Hymanella* because it is less densely pigmented than these other species. Maryland specimens ranged up to 13 mm in length.

Hymanella produces a large, dark cocoon that is carried within the body for several weeks before being deposited. This feature is unique to *H. retenuova* and when present is a useful character for its identification (Figure 1). Identification of all *Hymanella* cited in this study was verified by examination of sectioned material or retaining specimens in culture until they produced cocoons.

Maryland Distribution

We found *Hymanella* at twenty-five localities scattered generally throughout the state (Figure 6), although it was not collected on the Appalachian Plateau or in the interior of the Piedmont Province.

Ecology

Although *Hymanella* typically occurs in vernal pools, it has also been reported from a few spring-fed seeps and swamps (Ball et al. 1981; Castle 1941; Hyman 1955; Kenk 1949, 1970a). We found it twenty-four times in vernal pools (96%) and once (4%) in a permanent pond that received water from adjacent springs and seepage areas.

The life history of this species in a vernal pool in Massachusetts was documented in an extensive study by Castle (1941), who found that the cocoons were dormant while the pool was dry during summer and hatched when it filled with water in the fall. The planarians then matured, produced cocoons throughout winter and spring, and died when the pool dried in summer, leaving behind another generation of dormant cocoons. Cocoons were retained within the body for ten to 27 days before deposition. Some individuals produced as many as three cocoons. Cocoon extrusion was described by Chidester (1908) who noted that it first rotated within the atrium, then ruptured the atrial wall to pass through the parenchyma and emerge near the posterior end of the body. We frequently observed individuals with fresh wounds in that area. However, we also noted specimens with traces of old wounds located anterior of a developing cocoon. An overview of the biology of this species, with some notes on Maryland populations found by us, was given by Ball et al. (1981).

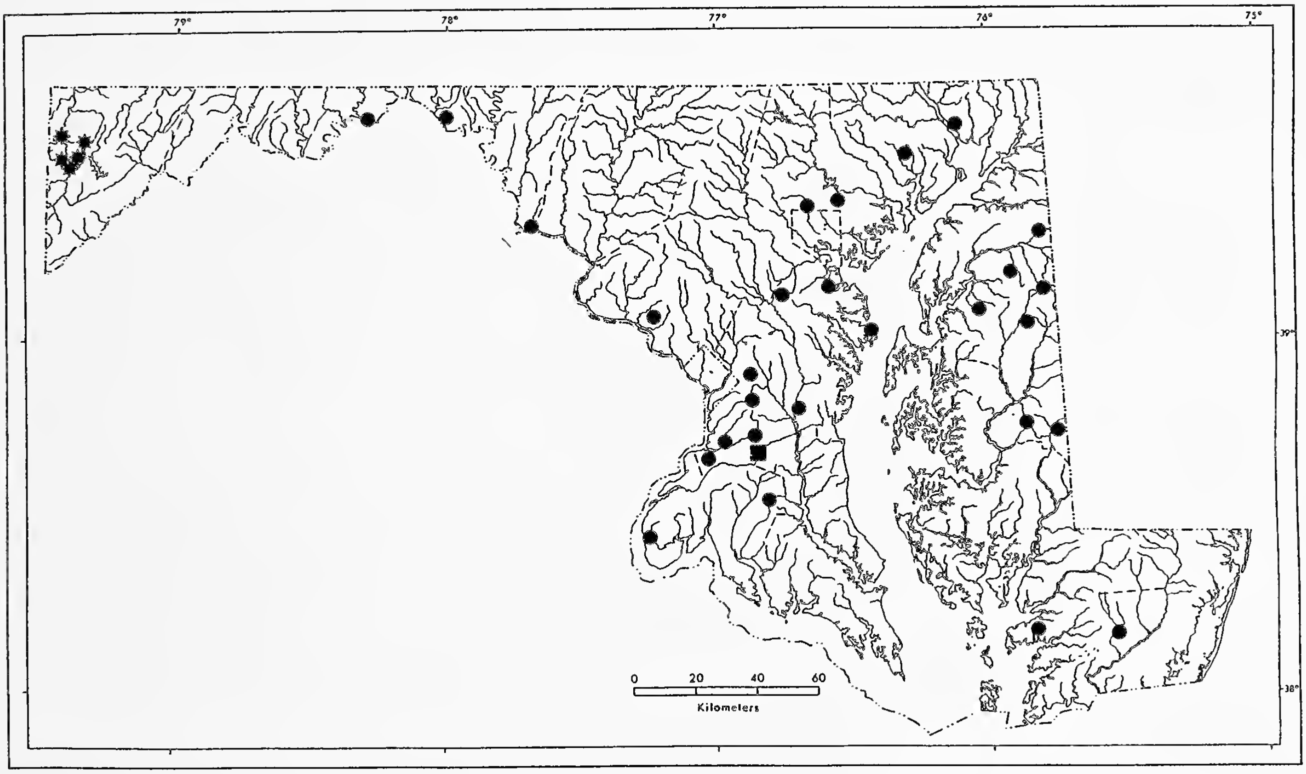

Figure 6. Known localities for *Hymanella retenuova* (●) and *Paraplanaria dactyligera* (✱) in Maryland. Square (■) indicates locality where both species occurred together.

We regularly found *Hymanella* in vernal pools from 25 January through 15 June. We also found one specimen in a seepage-fed permanent pond on 3 October, long after local temporary pools were dry. This supports Castle's (1941) suggestion that they might survive throughout the year in permanent ponds. At one vernal pool that was visited regularly throughout the season, we found active *H. retenuova* under a thick ice cover in January. At that time the planarians were sexually mature, and sexual individuals continued to be present until the pond dried in early June.

Several visits were made to that pool after dark so that observations could be made by flashlight. On a typical night visit hundreds of planarians were found to be present even though only small numbers could be found during the day. Both *H. retenuova* and *P. velata* were found moving over the substrate and on the surface film. Since the *P. velata* were noticeably darker and slimmer, it was possible to compare these two species as they foraged. The *Hymanella* were clearly less active and moved slower than did *P. velata.*

Hymanella retenuova is protandrous. The description of *H. retenuova* by Castle in 1941 was based on the female phase. Kenk subsequently described the male phase as *P. vernalis* in 1944. These two forms were not recognized as synonymous until recently (Kenk 1977b).

Temperature and selected water chemistry parameters obtained from 22 data collections for *H. retenuova* are given in Table 4.

General Distribution

H. retenuova ranges throughout eastern North America where it has been reported from Delaware, Louisiana, Maryland, Massachusetts, Michigan, North Carolina, Ontario, Rhode Island, and Tennessee (Ball et al. 1981).

Paraplanaria dactyligera (Kenk 1935)

Description

This is a pigmented planarian with a gently rounded frontal margin and no permanent auricles (Figure l). Two eyes are present. Maryland specimens ranged up to 13 mm in length. Some individuals show a slight narrowing behind the eyes. This species is externally very similar or identical to *Phagocata velata.* All populations of *Pa. dactyligera* found by us were verified by examining sectioned material.

Maryland Distribution

Paraplanaria dactyligera was found at seven localities in central Garrett County, and one isolated site on the Coastal Plain in Prince George's County (Figure 6). Despite intensive survey in the region between these distant sites, no additional populations of *Pa. dactyligera* were located. Kenk (1989) recently reported this species from Maryland based on material collected by us.

Ecology

The Garrett County localities were all small springs entering tributaries of the Youghiogheny River and were markedly similar ecologically. Each was a small, cool, pristine spring in an area of Pottsville Sandstone outcrop. The Coastal Plain locality, however, was a large, wooded vernal pool with a permanent spring at its edge.

Sexually mature individuals were present throughout the year but no cocoons were found associated with this species.

Temperature and selected water chemistry parameters obtained from 26 data collections for *Pa. dactyligera* are given in Table 4.

General Distribution

This species has been reported previously from Louisiana, Maryland, North Carolina, Tennessee, and Virginia (Kenk 1935, 1969, 1989; Longest 1966). Thus, these Maryland records are the northernmost in its range.

Phagocata gracilis (Haldeman 1840)

Description

This is a robust, pigmented planarian having a truncate anterior end with a slight bulge in the middle of the frontal margin, and a neck-like constriction behind the eyes (Figure 1). Maryland specimens ranged up to 30 mm in length. This species and *Phagocata woodworthi* are unique among local planarians in being polypharyngeal. The multiple pharynges are visible through the dorsal surface as a series of chevron shaped structures (Figure 1). These, and the characteristically shaped anterior end serve to separate *P.gracilis* and *P.woodworthi* from all other species in our area. *Phagocata gracilis* and *P. woodworthi* are externally identical and can only be separated by examining sectioned specimens.

Maryland Distribution

Phagocata gracilis was found at 45 localities, and was rather common everywhere except the Piedmont Province. Within the Piedmont, it was found only a few times along major rivers (Figure 7). Kenk (1989) recently reported this species from Maryland based on material collected by us.

Ecology

Phagocata gracilis was found in one pond and 44 streams. Among the streams it occurred in Order one streams (springs) 24 times (53.5%), Order two streams 15 times (33.3%), Order three streams once (2.2%), Order four streams twice (4.4%), Order five streams once (2.2%), and higher order streams once (2.2%). The streams inhabited by this species were typically small, with 40 (88.9%) measuring less that 1.6 m in width by 5.2 cm deep.

These observations agree fully with those of Kenk (1970b), who found *P. gracilis* to be an inhabitant of springs, the upper reaches of creeks, and occasionally cool ponds and lakes. He felt that temperature, "specifically the amplitude of its daily and seasonal fluctuations", was a principal factor determining its distribution. This is supported by laboratory studies performed by Eddy and Gleim (1932), who found that when placed in a temperature gradient *P. gracilis*

aggregated in the 0 to 9° C range. Speight and Chandler (1980) also tested this species in a temperature gradient and found that, although it selected primarily a range of 4 to 22° C, it preferred 14.8° C when the substrate was rock and 12.6° C when the substrate was moss.

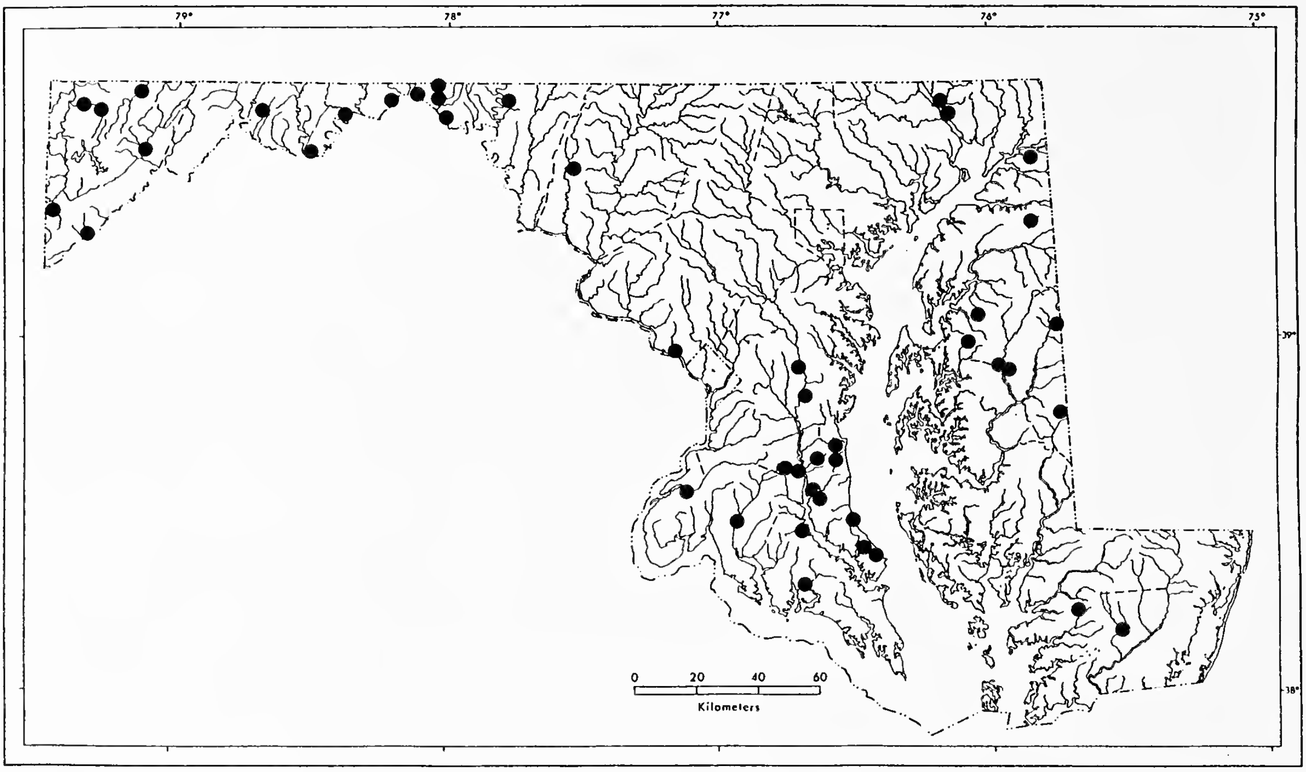

Figure 7. Known localities for *Phagocata gracilis* (●) in Maryland.

Temperature and selected water chemistry parameters obtained from 81 data collections for *P. gracilis* are given in Table 4.

General Distribution

This species occurs in eastern North America south and west of the Delaware River, where it has been reported from Arkansas, District of Columbia, Illinois, Indiana, Kentucky, Maryland, Michigan, Missouri, Ohio, Ontario, Pennsylvania, Tennessee, Virginia and West Virginia (Ball 1969, Kenk 1970b, Kenk 1989, Smrchek 1972).

Phagocata morgani **(Stevens and Boring 1906)**

Description

This is typically a white planarian, although ingested food frequently imparts a yellow or reddish tint to the body. The anterior end is truncate or gently rounded, and there may be a slight neck-like constriction behind the eyes (Figure 1). Two small eyes are normally present but

supernumerary eyes are common. Maryland specimens ranged up to 15.0 mm in length, but averaged about half that.

The absence of pigment separates *P. morgani* from all other Maryland planarians except *Procotyla fluviatilis*, *Pr. typhlops*, *Sphalloplana hoffmasteri*, and *Sphalloplana* sp. It differs from *Pr. fluviatilis* in lacking a visible anterior adhesive organ, and from *Pr. typhlops* and both species of *Sphalloplana* in having eyes (Figure 1).

Maryland Distribution

Although virtually absent from the Coastal Plain, *P. morgani* was found to be one of the most common species west of the Fall Line, where it occurred abundantly in every county and province (Figure 8). Its abundance west of the Fall Line makes its near absence from the Coastal Plain quite striking, especially since many of the streams that it inhabited west of the Fall Line continue onto the Coastal Plain. This species was previously reported from Maryland by Carpenter (1970), and Franz and Slifer (1971).

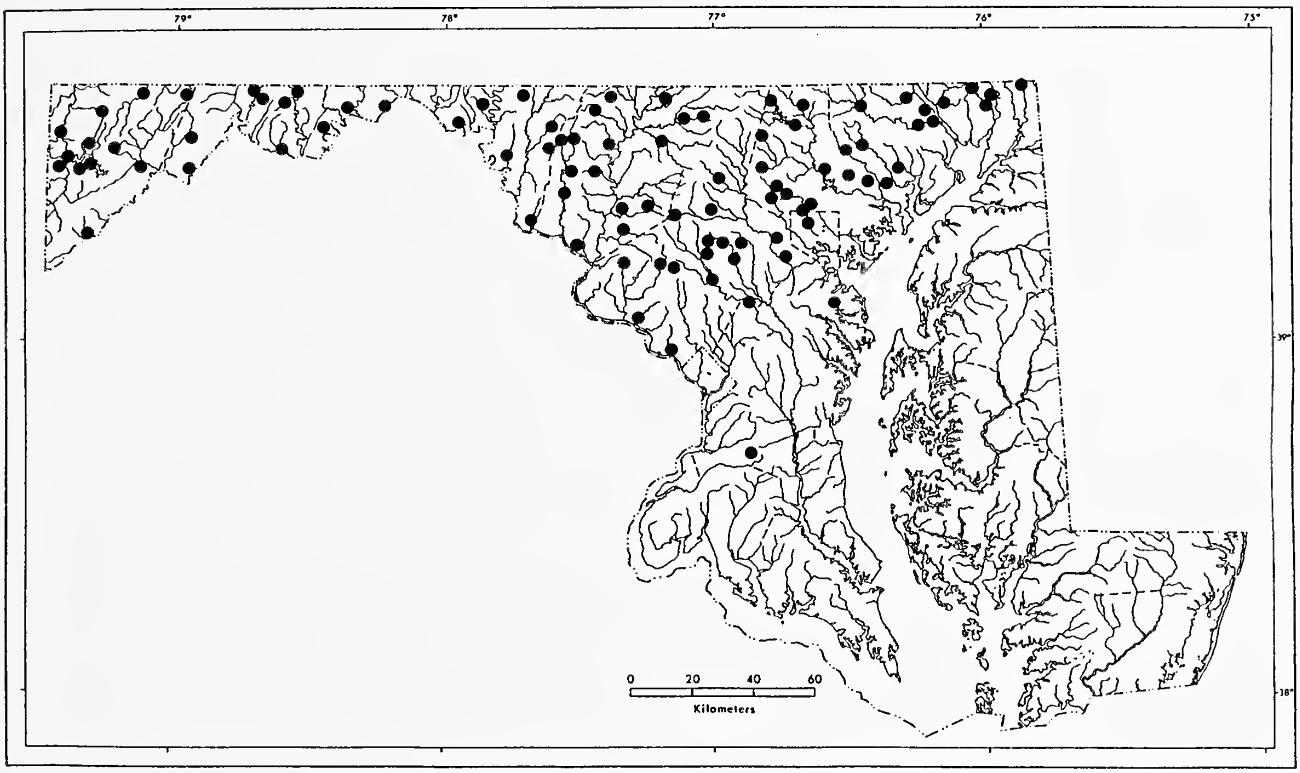

Figure 8. Known localities for *Phagocata morgani* (•) in Maryland

Ecology

Sexually mature *P. morgani* were found at 48 localities (52.2%), where they occurred throughout the year. Only asexual planarians were found at the remaining localities, and seven of these populations showed evidence of asexual reproduction by fission and regeneration at the

time of investigation. No newly hatched individuals or cocoons were found at any locality, suggesting that egg laying may take place in subterranean waters.

Of the 92 localities recorded for this species, 71 (77.2%) were Order one streams, 18 (19.6%) were Order two streams, and three (3.2%) were Order three streams. Two of these were completely contained in caves, and two others issued from cave entrances. Streams occupied by *P. morgani* were typically small and 71 (78.3%) were a meter or less in width. Several were discrete springs or ephemeral streams that dried completely in summer.

Phagocata morgani has been described as a planarian of springs, spring-fed ponds and the upper reaches of brooks (Givens 1953; Kenk 1935, 1944; Whitehead 1965), all situations having cool water with little temperature fluctuation. Most of our Maryland collections were from springs and all large populations were at spring heads or in caves. Many of our collections from Order two and three streams were made where springs flowed from the bed. The occurrence of *P. morgani* in caves, and springs and streams that dry in summer demonstrates that this species can readily survive in subterranean waters.

Both of the localities where we found this species on the Coastal Plain were unusually cool, spring fed habitats. The Prince George's County site, in particular, was a deeply shaded very cold spring run in a narrow, steep sided ravine that seemed much more typical of areas west of the Fall Line than the Coastal Plain. These two Coastal Plain occurrences are disjunct, and may represent relicts of a previously wider distribution

Teal (1957) studied the community metabolism of a spring in Massachusetts that contained both *P. woodworthi* and *P. morgani.* Since these two planarians were the "only two exclusively predatory animals in the spring", Teal suggested that *P. morgani* preyed on the much larger *P. woodworthi.* Although *P. woodworthi* did not occur with *P. morgani* in Maryland, we maintained *P. morgani* in culture with both *P. woodworthi* and the very similar *P. gracilis*, which we did find commonly with *P. morgani.* No predation was observed within these cultures, even when injured *P. gracilis* were made available to starving *P. morgani.*

Temperature and selected water chemistry parameters obtained from 178 data collections for *P. morgani* are given in Table 4.

General Distribution

Phagocata morgani ranges over the eastern half of North America where it has been reported from Alabama, Delaware, District of Columbia, Kentucky, Maine, Maryland, Massachusetts, Michigan, New Brunswick, New York, North Carolina, Ohio, Ontario, Pennsylvania, Quebec, Tennessee, Virginia, West Virginia, and Wisconsin (Ball 1969; Carpenter 1970; Darlington and Chandler 1972; Franz and Slifer 1971; Givens 1953; Kenk 1935, 1944, 1972; Stokley et al 1965; Teal 1957; Whitehead 1965). Although several of these states include portions of the Atlantic Coastal Plain there are no reported Coastal Plain records from anywhere outside of Maryland, and it appears that *P. morgani* now occurs generally in areas west of the Fall Line.

Phagocata velata (Stringer 1909)

Description

This is an eyed, pigmented planarian with a straight or gently rounded anterior margin and a neck-like constriction behind the eyes (Figure 1). Maryland specimens ranged up to 18 mm in length. Specimens that are about to undergo asexual reproduction by fragmentation and encystment lighten to grey and frequently develop pale blotches. Identification of all planarians cited as *P. velata* in this study was verified by examination of sectioned material or retaining specimens in culture until they underwent fragmentation.

Maryland Distribution

Phagocata velata was found at thirteen localities, twelve scattered throughout central Maryland and one on the lower eastern shore (Figure 9). We did not find it on the Appalachian Plateau in western Maryland.

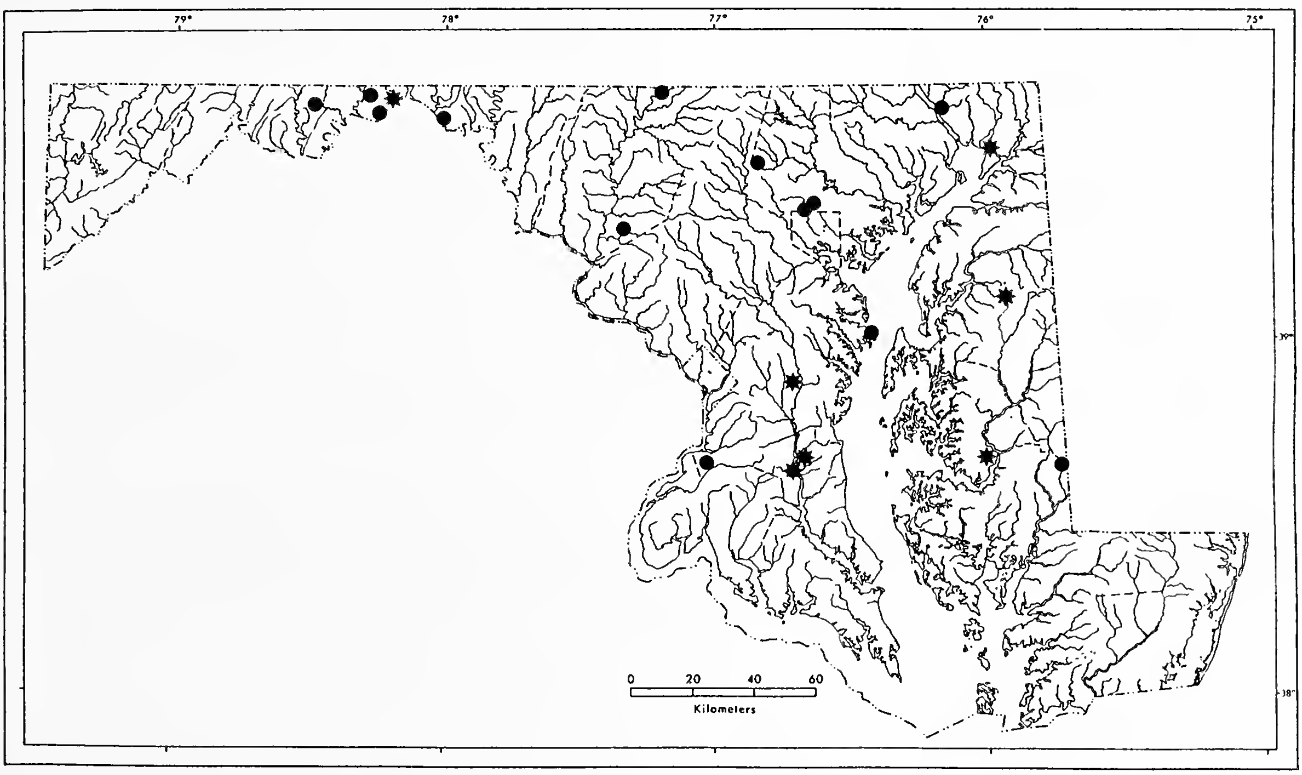

Figure 9. Known localities for *Phagocata velata* (●), and *Phagocata virilis* (✱) in Maryland.

Ecology

Phagocata velata inhabits springs, spring-fed brooks and marshes, and temporary pools (Castle 1927, 1941; Kenk 1944; Whitehead 1965). We found it seven times (53.8%) in Order one streams (springs or spring-fed habitats), and six times (46.2%) in temporary pools .

Phagocata velata is able to reproduce sexually or to undergo asexual reproduction by fragmentation and encystment (Ball et al. 1981). When reproducing asexually each planarian breaks itself into multiple pieces which secrete a mucus coat around themselves. These encysted pieces are then able to survive dry periods to eventually hatch into small but functional planarians. Although several European species of *Phagocata* also exhibit similar asexual reproduction, the only other North American species to do so is *Phagocata fawcetti* from California (Ball et al. 1981).

Castle (1927) studied the life history of this species in a spring in Indiana. He found that the planarians were small and uncommon during summer when the water temperature reached its maximum of 12-13° C. By late October, when the temperature had dropped to 8-9° C, they were becoming larger, developing sexual organs, and increasing in numbers. By the end of December the water temperature reached its minimum of 5° C and the planarians were active beneath the ice. Through January and February sexual reproduction was going on but decreased as temperatures started to rise in spring. As temperatures increased, sex organs disappeared and no sexual individuals were present by mid-March. Through April and May asexual reproduction by fragmentation and encystment occurred. Most individuals did encyst, but some persisted through summer as asexual planarians. These individuals presumably became sexual, and the dormant cysts hatched when temperatures again dropped in the fall. As noted previously, specimens that we observed developed very noticeable blotches prior to undergoing fragmentation. Higley (1917) made a similar observation and felt that the blotches became individual pieces when fragmentation occurred.

Castle (1927) showed in the laboratory that previously asexual individuals became sexual when kept at 8-10° C, and that sexual specimens lost their reproductive organs when cultured at 18-20° C. Child (1914) was able to culture this species through 13 asexual generations, demonstrating the effectiveness of asexual reproduction by fragmentation.

Speight and Chandler (1980) found that when *P. velata* was placed in a temperature gradient it generally aggregated between 16 and 20.5° C, and preferred 17.8° C. They also noted that it preferred a substrate of rocks to moss, leaves, sand or silt.

In Maryland we found *P. velata* from October to mid-June. Sexually mature individuals were found on 26 and 27 February, 11 March, and 25 April, at water temperatures of 6, 9, 7, and 13.5° C respectively. However, most specimens observed by us were asexual and fragmentation and encystment occurred commonly in culture. In one instance, several specimens collected in May encysted in a thermos bottle while being returned from the field.

At one vernal pool in Anne Arundel County we were able to observe both *P. velata* and *Hymanella* foraging at night. Since the *P. velata* were notable slimmer and more darkly pigmented, the two species were easily identified by flashlight. Under those conditions, *P. velata* clearly moved more rapidly that the *Hymanella*, and changed direction more often. Child (1913) also noted that *P. velata* was very active and moved more rapidly than other freshwater planarians that he had observed.

Temperature and selected water chemistry parameters obtained from 26 data collections for *P. velata* are given in Table 4.

General Distribution

P. velata ranges throughout much of the United States and eastern Canada, where it has been reported from Colorado, Georgia, Illinois, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Missouri, Nebraska, New York, North Carolina, Ontario, Quebec, South Carolina, Tennessee, Virginia, and Wisconsin (Ball et al. 1981, Darlington and Chandler 1981). Fawcett's (1969) report of this species from California actually represented a then undescribed species, *P. fawcetti*, which also undergoes asexual reproduction by fragmentation (Ball and Gourbault 1975).

Phagocata virilis Kenk 1977

Description

This is an eyed, pigmented planarian with a gently rounded or straight frontal margin and no prominent auricles (Figure 1). It is more robust than the other pigmented monopharyngeal species occurring locally. It also has a differently shaped anterior end. As Figure 1 shows, the head region of *H. retenuova*, *Pa. dactyligera* and *P. velata* flairs outward from the region of the eyes, while *P. virilis* generally slopes slightly inward. Maryland specimens ranged up to 14 mm in length.

Maryland Distribution

Prior to our survey, *P.virilis* was known only from its type locality, a seepage area along the Patuxent River in Prince George's County, Maryland (Kenk 1977b). We found it at six additional localities, five on the Coastal Plain and one in Washington County (Figure 9).

Ecology

These localities represent three distinct habitat types. The type locality was a freshwater seep along a large tidal river, and the seepage area is submerged at high tide. At that site the planarians were found under boards and at the bases of *Peltandra cordata*. The Washington County site was a cold, spring fed pool in the bed of the C & O Canal, where the planarians were found beneath the loose bark of submerged branches. That pool usually evaporated by mid-summer, but adjacent springs kept the soil wet. The remaining five sites (71.4%) were all shallow, vernal seepage fed swamps where planarians were found in accumulations of fallen leaves.

Temperature and selected water chemistry parameters obtained from seven data collections for *P. virilis* are given in Table 4.

General Distribution

Phagocata virilis has yet to be found outside of Maryland (Kenk 1989).

Phagocata woodworthi Hyman 1937

Description

Phagocata woodworthi is an eyed, pigmented, polypharyngeal species that is externally identical to *P. gracilis* (Figure 1). That combination of features separates it from all local species except *P. gracilis*. Internal examination of serially sectioned specimens is required to separate *P. gracilis* and *P. woodworthi*. Maryland specimens ranged up to 19 mm in length.

Maryland Distribution

We collected *P. woodworthi* at one locality in Cecil County (Figure 10). Both Hyman (1937) and Kenk (1970b) gave the Delaware River as the southern border of its range, and Kenk (1970b) provided an abundance of distributional data to indicate that the Delaware separated it from the range of *P. gracilis*. Therefor it was a surprise when, late in this study, Kenk identified our specimens from Elk Neck State Park in Cecil County as *P. woodworthi*. Kenk (1989) reported this species from Maryland based on that material.

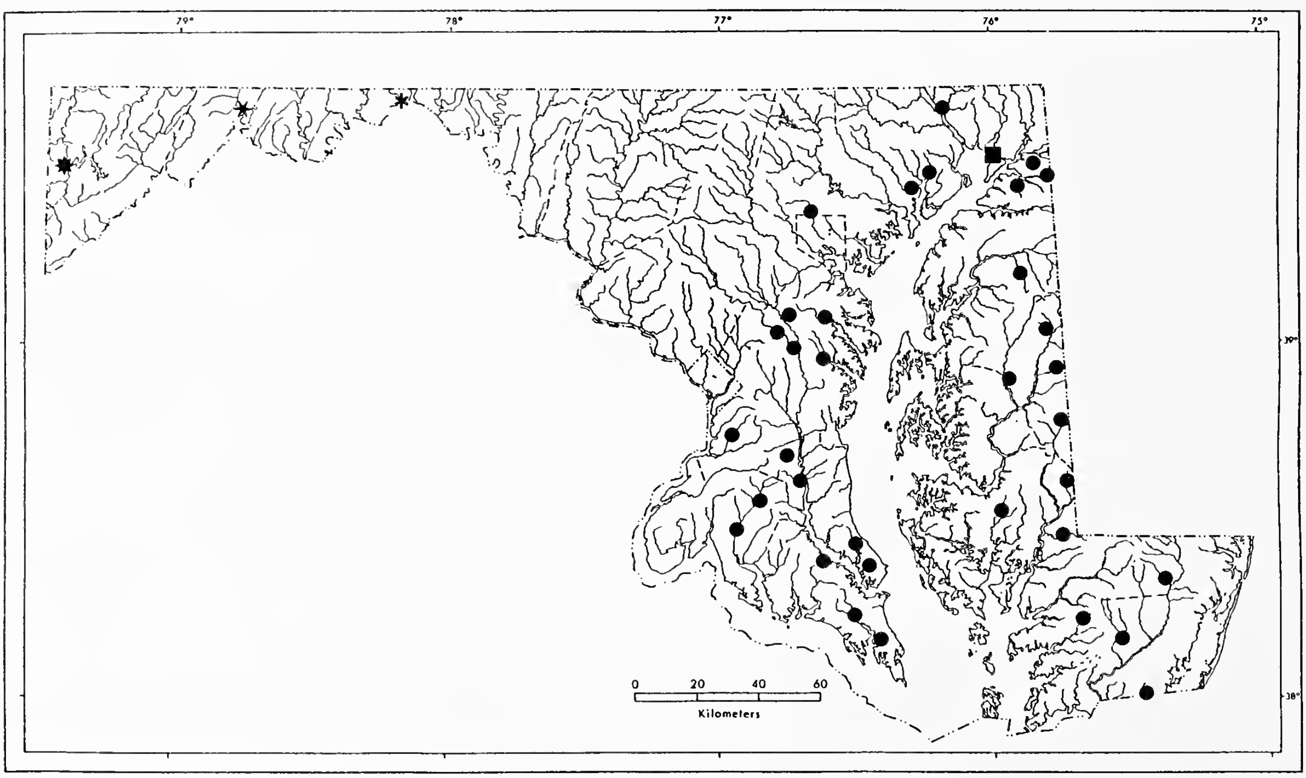

Figure 10. Known localities for *Phagocata woodworthi* (■), *Procotyla fluviatilis* (●), *Procotyla typhlops* (✱), *Sphalloplana hoffmasteri* (✱), and *Sphalloplana* sp. (✱) in Maryland.

Ecology

The single known Maryland locality is a seepage fed swamp in a steep-sided, wooded ravine. Kenk (1970b) characterized *P. woodworthi* as generally found in "ponds and rivers, more rarely in cold streams and springs." *Phagocata woodworthi* was a prominent element of the fauna of a spring in Massachusetts studied in detail by Teal (1957).

Temperature and selected water chemistry parameters obtained from three data collections for *P. woodworthi* are given in Table 4.

General Distribution

Phagocata woodworthi is generally distributed throughout the northeastern United States and Canada, where it has been reported from Connecticut, Maine, Maryland, Massachusetts, New Jersey, New York, New Brunswick, Newfoundland, Nova Scotia, Ontario, and Quebec (Hyman 1937; Kenk 1970b, 1989). This Maryland population represents the southernmost point in the known range of this species. *Phagocata woodworthi* has also been introduced into Loch Ness in Scotland (Reynoldson et al. 1981).

Procotyla fluviatilis Leidy 1857

Description

This is a large, white planarian with well developed eyes and an anterior adhesive organ that shows plainly as a denser semicircular area along the frontal margin (Figure l). The only other planarians in this area with a similar adhesive organ are the cave adapted species of *Sphalloplana*, all of which lack eyes. *Procotyla fluviatilis* typically has two primary eyes and a variable number of supplementary eyes. Maryland specimens ranged up to 23 mm in length.

Maryland Distribution

We collected *Pr. fluviatilis* at 34 localities. In Maryland it was generally restricted to the Coastal Plain with only slight encroachment onto the Piedmont Province (Figure 10).

Ecology

This large planarian was found in swamps or ponds nine times (26.5%), Order one streams five times (14.7%), Order two streams six times (17.7%), Order three streams 13 times (38.2%), and higher order streams once (2.9%). The streams were quite variable in width, ranging from 0.4 to 12.3 m in width. Two of the Order one streams were spring heads, and one was a drainage ditch that had scattered seepage areas along its sides. Chandler (1968), Darlington and Chandler (1972), and Longest (1966) all report finding *Pr. fluviatilis* in similar habitats.

Stewart (1972) studied the life cycle of this planarian for several years in Massachusetts, and found that cocoons were deposited from November to March, with egg laying peaking in

February. Hyman (1928) reported similar findings and noted that Massachusetts specimens studied by her were never sexually mature in summer. Although we did not find cocoons attributable to this species, we did collect sexually mature specimens during the summer months and numerous cocoons were deposited in culture.

Temperature and selected water chemistry parameters obtained from 76 data collections for *Pr. fluviatilis* are given in Table 4.

General Distribution

Procotyla fluviatilis occurs throughout the eastern half of North America where it has been reported from Arkansas, Connecticut, Delaware, Florida, Illinois, Indiana, Louisiana, Maine, Maryland, Massachusetts, Michigan, New Hampshire, New Jersey, New York, North Carolina, Ontario, Pennsylvania, Rhode Island, Tennessee, Virginia, and Wisconsin (Darlington and Chandler 1972, 1979; Hyman 1928, 1955; Kenk 1944, 1972, 1977b; Longest 1966; Stewart 1972).

***Procotyla typhlops* Kenk 1935**

Description

This is an eyeless, white planarian without a prominent anterior adhesive organ (Figure 1). This combination of characteristics will set it apart from all other local species except for *Sphalloplana hoffmasteri* and *Sphalloplana* sp. Certain identification of eyeless, white planarians from this area requires serial sectioning for internal examination. Any such planarians found should be forwarded to a triclad specialist for determination.

Maryland Distribution

This species was found only once, in a small spring in Garrett County on the Appalachian Plateau (Figure 10). Kenk (1989) recently reported this species from Maryland based on material collected by us.

Ecology

Our single locality for this species was a small spring flowing from the base of a large deciduous tree to form a stream about 0.7 m wide X 3.0 cm deep. Sexually mature individuals were present throughout the year but no cocoons or young were found. At this locality, *Pr. typhlops* was always uncommon among much larger numbers of *Pa. dactyligera*. Localities for this species outside of Maryland include a cold spring and a small seepage area (Kenk 1935, and personal communication).

Temperature and selected water chemistry parameters obtained from eight data collections for *Pr. typhlops* are given in Table 4.

General Distribution

This appears to be a truly rare species. In addition to this Maryland population, it is known with certainty only from two populations in Virginia, one each in Fairfax and Rockbridge Counties (Kenk 1935, and personal communication).

Hyman (1945, 1955) also reported *Pr. typhlops* from two sites in Florida. We discussed those records with Roman Kenk, who expressed the opinion that the specimens were so poorly preserved that identification was not possible. In 1972 Kenk commented that the Florida records for this species needed confirmation, and in 1974 he listed it from Florida with a question mark. However, in his 1989 synopsis of the North American fauna Kenk listed it from Florida without comment. We do not know why Kenk changed his mind about those records. Review of his detailed notes shows that he had no additional Florida material, nor did he reexamine the original specimens. Considering this, we support the position taken by Kenk in 1972 and 1974, and consider the occurrence of *Pr. typhlops* in Florida to be questionable and in need of confirmation.

Sphalloplana hoffmasteri (Hyman 1954)

Description

This is a robust, eyeless white planarian ranging up to 15 mm in length (Figure 1). The anterior margin may appear slightly truncated or rounded, and there is an anterior adhesive organ that may be visible as an opaque area in the center of the head region.

Maryland Distribution

This species was found at one locality in Washington County (Figure 10). Kenk (1989) reported this species from Maryland based on material collected by us.

Ecology

Sphalloplana hoffmasteri is a true troglobite that has been found only in subterranean streams and pools in caves, and one surface spring. The single Maryland locality is a small (<1 m), very shallow stream that trickles across the floor of an abandoned mine developed in the Tonoloway Limestone. According to Franz and Slifer (1971) it is likely that this mine was originally a natural cave. The only other animals observed in this stream were the planarian *P. morgani*, the subterranean amphipod *Stygobromus franzi*, and an undescribed subterranean isopod of the genus *Caecidotea*.

The stream occupied by *S. hoffmasteri* has been under observation by us for some years because we were also interested in the amphipod. Although surveyed carefully, no *Sphalloplana* were found on the first twelve visits made over a period of ten years. However, after finding it in 1982 it has been observed on every visit. Throughout this period there was no notable change in the stream or the other associated fauna, and the sudden appearance of this cave planarian remains unexplained. On the date of the first collection, we did note large numbers of

Stygobromus franzi attracted to the body of a dead big brown bat (*Eptiscius fuscus*) that was lying in the stream. However, on successive visits only normal numbers of *Stygobromus* were present.

In Maryland, sexually mature individuals have been found throughout the year. Although no cocoons were found associated with this species, small specimens (6-9 mm) were found in March, June and October.

Temperature and selected water chemistry parameters obtained from four data collections for *S. hoffmasteri* are given in Table 4.

General Distribution

Prior to our collection of this species in Maryland it was known only from West Virginia, where it was reported from caves and a spring in Greenbriar, Pendleton, Pocahontas, Randolph, and Tucker Counties (Kenk 1975).

Sphalloplana sp.

Description

This is a very slim, eyeless white planarian that narrows notably at the anterior margin (Figure l). The anterior end is truncated, with a generally straight frontal margin and a weakly developed central adhesive area. Specimens examined by us ranged up to 14 mm in length. The distinctive shape of the anterior end, narrow unpigmented body, and absence of eyes will separate this species from all other planarians known to occur in Maryland.

Identity

In life this species cannot be separated from *Sphalloplana subtilis* (Kenk 1977a). However, without examination of its internal anatomy certain identification is not possible. Since the shape of *S. subtilis* is unique among North American planarians, it is safe to say that this population represents either *S. subtilis* or an undescribed species. Our specimens are currently being studied by Dr. Ian Ball.

Maryland Distribution

This planarian was found at a single site in Allegany County (Figure 10).

Ecology

Our single locality for this species was a small spring on a steep hillside. The emergence was near the tree line but flowed down through a pasture. Specimens were found at the springhead as well as in the shallow run below. This spring was temporary and typically dried by mid-summer. We observed specimens in April, May and June. The spring site is underlain by the Helderberg Limestone. The valley below this spring contained many other springs, and

several caves with streams also occur in this area. However, considerable surveying failed to reveal additional localities for this species.

This spring also supports an unidentified subterranean amphipod of the genus *Stygobromus*, and the snail *Fontigens bottimeri*.

Temperature and selected water chemistry parameters obtained from three data collections for this species are given in Table 4.

General Distribution

If this species turns out to be *S. subtilis*, this will be its second known locality. *Sphalloplana subtilis* has been reported only from the type locality, a spring in Fairfax County, Virginia, which has been destroyed by a housing development (Kenk 1977a). If it is determined to represent a new species, this will be its only known site.

Discussion

Prior to this study, only six species of freshwater triclad planarians (*D. tigrina, H. retenuova, P. morgani, P. velata, P. virilis, Pr. fluviatilis*) had been reported from Maryland, each from a single locality. We found these six species at numerous localities and collected eight others for the first time (*D. dorotocephala, C. foremanii, P. gracilis, P. woodworthi, Pa. dactyligera, Pr. typhlops, S. hoffmasteri, Sphalloplana* sp). This is a remarkably diverse fauna for an area as small as the state of Maryland. We feel that this notable diversity results from Maryland's unique location and complex physiography. Maryland spans all three physiographic regions of the Atlantic Slope and is entered by tributaries of three major river systems, providing open avenues for the dispersal of aquatic species from most of the eastern half of the country, and offering a wide variety of aquatic conditions and habitat types.

In addition to these species, one additional freshwater triclad planarian has been reported from Maryland. In his recent synopsis of the distribution of North American species, Kenk (1989) reported *Phagocata bulbosa* from North Carolina and Maryland. The Maryland record was based on one specimen that Kenk found in a collection of *P. morgani* that we collected at Casselman Bridge State Park in Garrett County. Subsequent collections from that site yielded only *P. morgani*. Since the collection from which this *P. bulbosa* was taken had been kept along with identical containers that housed *P. bulbosa* from North Carolina, Kenk suggested to us that the specimen might have gotten into the Casselman Bridge culture by accident. In fact, his notes on this specimen include the comment "possibly accidentally transferred from other culture". Since all efforts to recollect *P. bulbosa* in Maryland have failed, and since its occurrence here would represent a considerable range extension, we feel that the specimen found by Kenk was probably placed with the Maryland collection in error. Consequently, we do not accept *P. bulbosa* as an element of Maryland's fauna.

Planarians were found at 431 sites in Maryland, but were recorded as absent at only 19. Localities where planarians were not found were either obviously polluted or had unstable,

shifting substrates lacking vegetation or other stable cover. Planarians were typically absent from all such localities examined, although several sites with indications of considerable organic enrichment supported large populations of *D. dorotocephala* or *D. tigrina*. Holsinger (1966) also reported *P. gracilis* thriving in an organically polluted habitat.

Table 1. Frequency of co-occurrence of Maryland planarians. Numbers given are percentages of total occurrence. The total number of collections for each species appears in parentheses following the species name.

	ASSOCIATED SPECIES														
SPECIES	*C. foremanii*	*D. dorotocephala*	*D. tigrina*	*H. retenuova*	*Pa. dactyligera*	*P. gracilis*	*P. morgani*	*P. velata*	*P. virilis*	*P. woodworthi*	*Pr. fluviatilis*	*Pr. typhlops*	*S. hoffmasteri*	*Sphalloplana* sp.	NONE
C. foremanii (43)	X	4.7	39.5	-	-	9.3	16.3	-	-	-	9.3	-	-	-	20.9
D. dorotocephala (21)	9.5	X	14.3	-	-	9.5	4.8	-	-	-	4.8	-	-	-	57.1
D. tigrina (154)	11.0	1.3	X	-	-	3.3	-	-	-	-	9.7	-	-	-	74.7
H. retenuova (25)	-	-	-	X	-	-	-	24.0	-	-	12.0	-	-	-	64.0
Pa. dactyligera (8)	-	-	-	-	X	-	28.6	-	-	-	-	14.3	-	-	57.1
P. gracilis (45)	8.9	4.4	11.1	-	-	X	24.4	4.4	2.2	-	17.8	-	-	-	46.7
P. morgani (92)	7.6	1.1	4.4	-	2.2	12.0	X	1.1	-	-	-	-	1.1	-	70.5
P. velata (13)	-	-	-	46.1	-	-	7.7	X	-	-	-	-	-	-	46.2
P. virilis (7)	-	-	-	-	-	14.3	-	-	X	14.3	28.6	-	-	-	42.9
P. woodworthi (1)	-	-	-	-	-	-	-	-	100.0	X	-	-	-	-	-
Pr. fluviatilis (34)	11.8	2.9	44.1	8.8	-	23.5	-	-	5.9	-	X	-	-	-	55.8
Pr. typhlops (1)	-	-	-	-	100.0	-	-	-	-	-	-	X	-	-	-
S. hoffmasteri (1)	-	-	-	-	-	-	100.0	-	-	-	-	-	X	-	-
Sphalloplana sp. (1)	-	-	-	-	-	-	-	-	-	-	-	-	-	X	100.0

We found that two or more species frequently occurred together. In most instances these species were truly syntopic with individuals of each taxa occurring side by side. With the exception of *Sphalloplana* sp., all local planarians were found with another at least once (Table 1), although the frequency of occurrence with other species decreased with larger sample size. For instance, the two most frequently collected species (*D. tigrina* and *P. morgani*) were found alone the greatest number of times. Only three species (*P. woodworthi*, *Pr. typhlops*, *S. hoffmasteri)* occurred with another 100 percent of the time. However, since each of these was found at only a single site, little meaning can be attributed to this. Although the others frequently coexisted, most occurred alone more often than with any other species. Still, the frequency with which they were found together indicates a significant overlap in habitat preferences.

Table 2 indicates that a fair degree of spatial separation exists between locally occurring species. Only *D. tigrina* and *Pr. fluviatilis* were regularly found in permanent ponds while *H. retenuova, Pa. dactyligera* and *P. velata* were the only species found in temporary ponds. In streams, planarians were found by themselves 76.1% of the time, with one other species 17.6%, with two other species 6.0%, and with three other species only 0.3% of the time. This is partly due to allopatric distributions, and apparently partly a result of subtle differences in habitat preference of syntopic species. For instance, *P. morgani, P. virilis*, and *Pr. fluviatilis* all occur in Order one streams (Table 2), but *Pr. fluviatilis* and *P. virilis* were found together only twice and neither were ever found with *morgani* (Table 1). Another example is provided by *C. foremanii* and *P. morgani*, both of which occur west of the Fall Line, but were found together relatively few times because *P. morgani* generally inhabits Order one streams (77.2%) while *C. foremanii* usually inhabits Order two, three and four streams (79.1%).

The distribution of several species in Maryland is closely associated with one or more physiographic provinces (Table 3). These correlations seem to be with the provinces themselves and not with drainage basins. For instance, the ranges of both *P. morgani* (Fig. 8) and *Pr. fluviatilis* (Figure 10) generally stop at the edge of the Fall Line, which separates the Coastal Plain and Piedmont Provinces, even though the streams in which they occur extend onto the adjoining province.

Other species, such as *D. tigrina* (Figure 5) were found throughout the state, or occurred nearly state wide except for unexplained but apparently real gaps. For instance, both *C. foremanii* (Figure 3) and *Hymanella* (Figure 6) were found widely but were rare or absent in the western counties, and the range of *P. gracilis* (Figure 7) shows a peculiar hiatus in central Maryland. *Phagocata virilis* (Figure 9) is typically a Coastal Plain species except for a single site in Washington County, while *Pa. dactyligera* (Figure 6) shows a local range that is nearly the reverse, with a tight cluster of sites in Garrett County and one locality on the Coastal Plain. The remaining four species were found so few times that little can be said, except that *Pr. typhlops* (Figure 10) seems to be a rare spring or groundwater inhabiting species with a few disjunct populations, *P. woodworthi* (Figure 10) is a northeastern form that just reaches Maryland at the southern edge of its range, and *S. hoffmasteri* (Figure 10) and *Sphalloplana* sp. (Figure 10) are both uncommon subterranean species.

Table 2. Frequency of occurrence of Maryland planarians with various types of water bodies. Numbers given are percentages of total occurrence. The number of collections for each species appears in parentheses following the species name. Permanent ponds category includes swamps and bogs, and temporary seepage areas are grouped with Order one streams.

Species	TYPE OF WATER BODY Order One Stream	Order Two Stream	Order Three Stream	Order Four Stream	Order Five Stream	Order Six Stream	Higher Order Stream	Swamps/Ponds	Temporary Ponds
C. foremanii (43)	20.9	44.2	30.2	4.7	-	-	-	-	-
D. dorotocephala (21)	23.8	28.6	23.8	9.5	4.8	-	9.5	-	-
D. tigrina (154)	8.4	28.6	33.8	5.8	1.9	0.7	5.2	15.6	-
H. retenuova (25)	-	-	-	-	-	-	-	4.0	96.0
Pa. dactyligera (8)	87.6	-	-	-	-	-	-	-	12.4
P. gracilis (45)	53.5	33.3	2.2	4.4	2.2	-	2.2	2.2	-
P. morgani (92)	77.2	19.6	3.2	-	-	-	-	-	-
P. velata (13)	53.8	-	-	-	-	-	-	-	46.2
P. virilis (7)	100.0	-	-	-	-	-	-	-	-
P. woodworthi (1)	100.0	-	-	-	-	-	-	-	-
Pr. fluviatilis (34)	14.7	17.7	38.2	-	-	-	2.9	26.5	-
Pr. typhlops (1)	100.0	-	-	-	-	-	-	-	-
S. hoffmasteri (1)	100.0	-	-	-	-	-	-	-	-
Sphalloplana sp. (1)	100.0	-	-	-	-	-	-	-	-

As Table 4 shows, there are differences in the environmental parameters determined during this study for those species occurring in Maryland. However, there is generally such broad overlap that none of these factors appears to be acting to limit distributions. Other abiotic factors may play a role, or the major constraints on local range may be biotic. This seems to be the case in Europe where much research has been done on planarian biology, and where competition and its avoidance have emerged as major factors effecting distribution (Davies and

Reynoldson 1971; Lock and Reynoldson 1976; Reynoldson 1966, 1975; Reynoldson and Bellamy 1970, 1973; Reynoldson and Davies 1970; Wright 1968, 1974, 1975).

Table 3. Occurrence of Maryland planarians with physiographic regions. Presence is indicated by X or *, absence by -. Asterisk (*) indicates a few occurrences, with a large number of sites in other provinces. Number of localities appears in parentheses following the name of each species.

	PHYSIOGRAPHIC REGION					
SPECIES	Coastal Plain Eastern Division	Coastal Plain Western Division	Piedmont Province	Blue Ridge, Ridge & Valley, Great Valley	Appalachian Plateau Atlantic Drainage	Appalachian Plateau Ohio River Drainage
C. foremanii (43)	X	X	X	X	-	-
D. dorotocephala (21)	-	-	X	X	-	-
D. tigrina (154)	X	X	X	X	X	X
H. retenuova (25)	X	X	X	X	-	-
Pa. dactyligera (8)	-	*	-	-	-	X
P. gracilis (45)	X	X	*	X	X	X
P. morgani (92)	-	*	X	X	X	X
P. velata (13)	*	X	X	X	-	-
P. virilis (7)	X	X	-	*	-	-
P. woodworthi (1)	X	-	-	-	-	-
Pr. fluviatilis (34)	X	X	X	-	-	-
Pr. typhlops (1)	-	-	-	-	-	X
S. hoffmasteri (1)	-	-	-	X	-	-
Sphalloplana sp. (1)	-	-	-	X	-	-

Table 4. Environmental parameters (range/mean) determined for localities where planarians were found in Maryland.

Species	n =	Temp. °C	pH	Dissolved Oxygen (ppm)	Dissolved CO2 (ppm)	Total Alkalinity (ppm)	Calcium Hardness (ppm)
Cura foremanii	63	2.0-22.0	6.0-9.5 (7.0)	4.0-54.8 (10.5)	0-55.3 (7.3)	0-156.0 (38.5)	3.0-243.0 (42.3)
Dugesia dorotocephala	37	3.5-25.5	6.0-10.0 (8.0)	5.3-53.6 (11.9)	0-25.0 (7.2)	0-231.0 (102.9)	110.0-261.0 (87.1)
Dugesia tigrina	223	3.0-34.0	4.0-10.1 (6.9)	1.1-69.6 (9.4)	0-68.8 (7.3)	0-224.0 (40.6)	0-243.0 (49.4)
Hymanella retenuova	22	2.0-22.5	5.5-5.8 (6.4)	1.4-15.4 (6.7)	3.8-70.0 (21.2)	15.0-229.0 (44.7)	17.0-144.0 (67.8)
Paraplanaria dactyligera	26	5.0-14.0	5.0-6.5 (5.7)	2.8-14.3 (9.2)	2.4-32.5 (14.4)	0-48.0 (11.0)	0-47.0 (17.2)
Phagocata gracilis	81	2.5-25.0	6.0-10.0 (7.2)	2.2-53.6 (10.4)	0-50.4 (8.0)	0-270.0 (79.2)	0-256.0 (71.0)
Phagocata morgani	178	1.0-23.0	4.0-11.5 (6.7)	0.9-54.8 (11.4)	7.0-130.8 (14.6)	0-336.0 (65.8)	0-255.0 (60.7)
Phagocata velata	26	2.0-25.5	5.5-8.5 (6.8)	1.4-53.6 (10.6)	2.6-72.6 (15.5)	12.0-229.0 (51.7)	6.0-144.0 (66.6)
Phagocata virilis	7	6.0-20.0	5.5-6.0 (5.8)	0.8-3.0 (2.4)	17.2-60.2 (39.8)	16.0-31.0 (25.0)	22.0-52.0 (34.0)
Phagocata woodworthi	3	7.0-18.5	6.5 (6.5)	9.9-10.8 (10.3)	0-6.3 (2.7)	18.0-19.0 (18.5)	46.0-92.0 (76.6)
Procotyla fluviatilis	76	4.0-26.5	5.0-10.0 (7.1)	0.8-17.6 (8.8)	0-68.8 (10.9)	0-202.0 (52.1)	0-256.0 (53.9)
Procotyla typhlops	8	5.5-13.0	5.5 (5.5)	5.5-12.4 (8.7)	12.6-32.5 (19.3)	7.0-15.0 (10.9)	3.0-17.0 (13.5)
Sphalloplana hoffmasteri	4	7.0-8.0	8.5-9.0 (8.8)	8.6-13.4 (11.2)	5.4-7.8 (6.3)	116.0-265.0 (179.0)	193.0-211.0 (206.0)
Sphalloplana sp.	3	11.5-13.0	7.5 (7.5)	7.4-8.2 (7.7)	3.2-4.8 (3.9)	215.0-233.0 (222.0)	119.0-150.0 (136.0)

Some of the earlier investigations into planarian ecology examined the role of various water chemistry features as determinants of distribution and abundance, and suggested that such features as pH (van Oye 1941), calcium concentration (Hyman 1925, Jenkins 1964), dissolved salts (van Oye 1941), and dissolved organic matter (Chandler 1966) played an important role. However, more recent studies indicate that these factors are not important. In some instances, there may be real correlations, but the chemical characteristic itself may not be directly effecting the planarians. For instance, several studies have shown a positive correlation between both planarian density and diversity, and increased calcium concentration (Chandler 1966, Reynoldson 1966). However, it has been shown that the greater abundance of individuals and species of planarians in calcium rich waters is a response to the greater productivity of such habitats which results in a more abundant and varied assemblage of potential prey species (Reynoldson 1966, 1974).

Several abiotic features that do seem to influence the distribution of freshwater triclad planarians are gradient and/or water velocity (Kawakatsu 1974, Wright 1968), and water temperature. Water temperature has been indicated as being particularly important and various species have been identified as stenotherms or eurytherms. However, this relationship is not clearly established and we found that in Maryland supposed stenotherms such as *P. morgani* and *D. dorotocephala* frequently occurred at temperatures higher than those at which *D. tigrina*, a clear eurytherm, was found. Still, the temperature "preferences" of various species, as identified in laboratory studies, can differ significantly (Eddy and Gleim 1932, Kawakatsu 1974), and this area of planarian biology deserves additional attention. Indications that temperature requirements do influence distribution have come from several studies that examined the detailed distribution of species along a stream gradient, where a stenothermic headwater species was replaced downstream by a possibly more eurythermic species. Kawakatsu (1974) working with Japanese planarians, Chandler (1966) studying *P. gracilis* and *C. foremanii* in Indiana, and Reynoldson (1974) reporting observations made by Sandra Harris on *D. dorotocephala* and *D. tigrina* in California, all documented seasonal changes in species distribution correlated with seasonal changes in water temperature. In each instance, the presumably more stenothermic headwater form shifted farther downstream during cooler periods and the more eurythermic downstream form shifted upstream during warmer periods.

It has also been suggested that predation by one planarian on another could effect their distribution. Fawcett (1969) found that *D. dorotocephala* actively sought out and consumed *Phagocata fawcetti* in laboratory cultures, even when alternative food items were available. Because of this he suggested that *D. dorotocephala* could successfully exclude *P. fawcetti* from permanent streams, and was responsible for its restriction to temporary streams, where *D. dorotocephala* was at a disadvantage. In Maryland we found *D. dorotocephala* associated with five other species (Table 1), and successfully reared this species in culture with other planarians on numerous occasions. As noted previously, Teal (1957) suggested that *P. morgani* was a predator of *P. woodworthi* in the spring that he studied in Massachusetts. However we maintained these species in culture for long periods without evidence of predation.

Although much work remains to be done on basic planarian ecology before any definitive statement can be made about which factors influence the distribution of local planarians, the picture that emerges from existing information from other areas is that the distribution of various

species results from subtly different habitat preferences interacting with interspecific competition for available food resources. Where such resources are abundant and diversified, the planarian community becomes abundant and diversified. However, where food reserves are critical, the differences in habitat preference demonstrate themselves.

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Erratum

Scarpulla, E. J. 1989 (1991). First Records for the Leatherback Turtle (*Dermochelys coriacea*) Along Maryland's Atlantic Coast. *The Maryland Naturalist* 33(3-4):59-60.

In this paper the name of one of the observers, Ms. Carol W. Ansell, was accidentally given as Carol W. Angel. The editor regrets this error.

The Maryland Naturalist is a quarterly publication of the Natural History Society of Maryland. Subject matter includes all areas of the natural history of Maryland and adjacent states. Suitability of manuscripts will be determined by the editor. All accepted manuscripts will be reviewed by appropriate specialists prior to publication. Address all manuscripts and correspondence to Editor, *The Maryland Naturalist*, Natural History Society of Maryland, 2643 North Charles Street, Baltimore, Maryland 21218.

Manuscripts submitted for consideration should be typed, double spaced, on good quality bond paper with adequate margins. Authors should adhere generally to the *Council of Biology Editors Style Manual*. However, individuality and readability of writing style are encouraged.

Contributions other than short notes may include a brief informative abstract. Payment of page charges is not required for publication in *The Maryland Naturalist*. However, if funds are available, assistance to offset publication costs would be welcome.

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Arnold W. Norden, Editor

Mailing Date: 29 May 1992

Cover Illustration: Ant, *Aphenogaster rudis,* with diaspore (seed and elaiosome) of twinleaf, *Jeffersonia diphylla.* From an original watercolor by Warren E. Steiner, Jr.

EDITOR'S PAGE

On the evening of June 19, 1991, Dr. Elmer George Worthley died quietly at his home in Finksburg, Maryland. Elmer had been a member of the Natural History Society of Maryland for 37 years. He is survived by his wife Jean, six children and two grandchildren.

I first met Elmer at the Natural History Society over twenty years ago. At that time I had a bad case of tunnel vision that prevented me from seeing anything that was not a snake, lizard or turtle. Although a lecture was scheduled that night, I was there primarily to show off my first corn snake, which I had collected earlier that day and was then in a bag in my pocket. Unfortunately, there were no Herp Society members present, so I had little chance to brag about my good luck. However, after the talk I was approached by a large, bearded man who someone had mentioned was a botanist. Although not in the least interested in plants I was glad for the opportunity to bring out the snake. The botanist spent a few moments looking it over with the hand lens that he had strung around his neck, then proceeded to tell me about the mites that were present between the snake's chin scales and a tick that still adhered to its tail. He also told me about the milk snakes in his mother-in-law's basement, the decline of fence lizards at Soldier's Delight, the use of vertical stratification of pondside vegetation by tree frogs to avoid hybridization, and the correct scientific name of the alga that lives within the jelly envelope around amphibian eggs. Not bad for a botanist!

That person, of course, was Elmer Worthley, and the event is so typical that any of his friends can spin off a dozen others just like it. Elmer had more stored knowledge about more different things than anyone I have ever met, and he was always eager to share it with anyone who was even remotely interested, or even if they were not. However, I almost always was, so there was seldom a problem. When a problem did arise, it was invariably because Elmer needed to tell me more than I wanted to know or had time to hear. In those instances, he usually talked me to my car and sometimes halfway down the driveway.

Any request to Elmer for information, no matter how casual and innocent, always resulted not only in a wealth of verbal gems, but more books than you could carry. Books were one of Elmer's real loves and he and Jean accumulated a truly remarkable library. They had books about everything and Elmer usually insisted that you take some of them with you. I recall numerous occasions when Elmer sent me home with the back seat of my old Volkswagen filled with hundreds of dollars worth of books. For years those loans were made on the honor system, but later Elmer started keeping a record by jotting down who borrowed what on small slips of paper from a pad that was always in his pocket, along with a pen. In fact, the pen and pad in his pocket and the hand lens around his neck were part of Elmer's everyday dress and I never recall seeing him without them. The only problem with the pen and pad recording system was that the slips were occasionally not destroyed when a book was returned, and sometimes showed up years later.

Elmer also liked to see an appreciation of books in others. Once, when my wife Beth and I were present at one of Elmer and Jean's Christmas gatherings at Owings Mills, Elmer had just opened a package containing a set of the *Flora of West Virginia* that he had ordered. I casually mentioned that we really needed to save enough to buy a set of the same books. Instead of

putting his name inside the cover, Elmer wrote in a personal inscription to Beth and me and handed them over to us. Those four volumes still hold a special place on our bookshelf.

Elmer constantly jotted down notes, using the ever present pen and pad. He recorded the names and characteristics of interesting invertebrates, he wrote down the titles of books that he might want to get and journal articles that he felt he should read, he wrote things down in libraries, sitting in restaurants, talking on the street, and driving down the road. I don't know what ever happened to all those slips of paper, but somewhere Jean must have thousands of them. He also put notes inside the covers of his books, and many times I found important additional references on slips of paper stuck inside the back cover of some reference text. Elmer had found a great way to keep his textbooks current!

I didn't attended Elmer's class (although I was an occasional guest lecturer), mainly because he expected regular attendance, which I could never guarantee. Still, I visited the Worthley homestead frequently, and every visit was the same. The door was never locked (even when no one was home) and the welcome mat was out. Elmer always took me for a tour of the property to point out what had just been planted and what was blooming, fruiting, or doing nothing, then we would sit down for a long talk about what we had been doing and what new books he had purchased.

Although Elmer was most at home with plants, he was a true all-around naturalist. As I explored various areas of the natural sciences, Elmer was overjoyed to discuss them with me, particularly when I settled into lichens and invertebrates, two areas that he wanted to know more about. I went into the field many times with Elmer, and enjoyed every trip. However, there was frequently a real element of frustration because Elmer had his own agenda. Having a goal in mind was one thing, but reaching it with Elmer Worthley was quite another. Many times I wound up going my own way, with Elmer eventually catching up or my meeting him on the way back to the car, usually at some point near the road where he had discovered a patch of interesting bryophytes.

In the following pages Dave Lee gives a somewhat deeper glimpse of Elmer Worthley than I can here. However, as he states, he passed over most of the "drier details." The following notes should help fill that gap. Elmer Worthley was born in Newburyport Massachusetts in 1921. He earned his B.S. at the University of Massachusetts in 1947, a M.Sc. at Brown University in 1951, and his Ph.D. at the University of Maryland in 1957. Elmer served as president of the Maryland Ornithological Society and was the Founding President of the Horticultural Society of Maryland. From 1953 to 1981 he was employed by the U.S. Government at the Edgewood Arsenal. The day that Elmer died, 19 June 1991, was also his 43rd wedding anniversary.

In his later years Elmer wasn't very big on the Natural History Society of Maryland. I think he felt that we were too set in our ways and a bit stodgy (he was probably correct). Still, I don't think he'd mind if we dedicate this issue to his memory. Elmer G. Worthley was one of the finest men that I have ever met, and was easily the best naturalist. He will be sorely missed. This issue of *The Maryland Naturalist* contains five papers, three of which were written by Elmer's students.

Elmer George Worthley- A Maryland Naturalist

David S. Lee

The master was an old Turtle- we called him tortoise-
Why did you call him Tortoise, if he wasn't one? Alice asked.
We called him Tortoise because he taught us, said the Mock Turtle angrily.... Really, you are very dull!

For me the preceding lines, written by Lewis Carroll in 1863, capture some of the characteristics of my subject, Dr. Elmer George Worthley. They also suggests the futility of my goal, not so much trying to describe the person, but rather to capture his spirit. You would first have to know the man to understand all this. It's too bad that not everyone has the opportunity to know someone like Elmer Worthley. Not that it's hard to know people of this sort, in fact, the opposite is true. The problem is that there are so few of them to go around.

Back in 1971, it was in February, I signed up for a plant taxonomy class that was starting up at the Baltimore campus of the University of Maryland. Looking back, I'm not really sure why I signed up for that course. I didn't like botany and I already had a number of dull botany courses to my credit. However, I'm glad that I did because what ensued was an unexpected surprise. At the first lecture I learned more about native Maryland plants from the professor, Dr. Elmer Worthley, than I had been exposed to in all my previous courses.

I still recall the first class in detail. We learned to identify plants from leafless winter twigs. Dr. Worthley hid himself in a frugal, New England country boy's shell, tucked behind an endless string of botanical trivia and scientific names. A tortoise indeed, Elmer hid not just within his botanical knowledge, but in an over-sized intimidating body, clothed with no thought of style or fashion. Large, loose-fitting khaki pants were held above his worn Hushpuppys by bold red-striped suspenders. On anyone else the suspenders would have clashed with the red plaid shirt, but on Elmer it didn't seem a point worth noting. Practicality and comfort mattered, other things didn't. His thick-rimmed glasses always seemed as if they belonged to another face. He had a grey moss-like beard that looked as if it had been snatched from a live oak. Elmer's slow deliberate speech could have been Southern if it weren't for the pronounced New England accent.

What I first noticed about Elmer was his enthusiasm and his ability to make trivia relevant. We all have had classes which we could categorize as good or bad, based entirely on qualities of the instructor, but simply to score this one as good just isn't sufficient. I'll skip the superlatives, and just say that the one-semester course that I signed up for in the winter of 1971 was still in progress when Elmer died, over nineteen years later. Elmer's enthusiasm was contagious.

During my previous years of formal education, I survived a number of education courses that were required for teacher certification. Besides learning how to run movie projectors, we

were taught all the things to avoid if one is to be a successful classroom teacher. I did not carry a score card, but I'm convinced Elmer avoided or broke every teaching guideline ever put down on paper. There is one unwritten rule of thumb, however, that Elmer never broke. I learned it years earlier in Education 601. My instructor noted, as an afterthought, "If you can't recall all this stuff just remember one thing. Know your subject", he paused for affect, "know it very well and everything else will take care of itself." Elmer knew his subject better than anyone I ever knew.

Elmer's teaching style made his class poorly suited to those with low-esteem. Elmer taught through intimidation and challenge, and sometimes felt that he could stimulate curiosity through personal embarrassment. If anyone ever said that they understood some point when they really did not, Elmer somehow knew and invariably put them on the spot by asking for a full explanation. He also used teaching methods which others might think bordered on the absurd. One night we went out and learned to find and identify the previous season's dried goldenrod stalks, by touch in the moonlight. When we finally got to one that for all the world felt like one we had been introduced to half-an-hour before, we were informed that "Yes, while you are correct about the shape and feel, the previous species never grows in damp soil." Its habitat was forever imprinted on us when we realized we were standing in ankle deep water. It was early March, if I remember correctly, the spring peepers were calling and my feet were very cold.

From those who survived the first few weeks of class grew a steady following. Word spread and the class grew larger. Every so often Elmer sharpened his embarrassment shears and pruned the class back to a workable size. The course had been set up for University of Maryland pharmacognosy students and a number of free-spirits, decidedly nonacademic, had signed up. It soon became clear to Elmer that their true interest was not in the medicinal value of plants in the traditional sense, but in the discovery of those with hallucinogenic qualities. No one from that segment of the class made it past the first semester. For those who hung in there it was an enriching experience, a class held once a week in the Professor's home, and once each month a two-day field trip to some high quality, botanically rich, secluded site where we could learn plants without distraction.

Just as plants are best understood in their natural habitat so it was with Elmer. His chosen environment was his home. The Worthley home was a living classroom. Elmer, and his wife Jean, converted the rambling family farm into a diverse botanical garden and the house was a walk-in library, with books in piles on tables, books with photo copies escaping from the covers, walls of books, rooms of books. The shelves sagged, the house sagged. Chairs, tables and windows were blocked by tottering piles of books. The books were not just about plants, there were books on Philippine eels, bird eggs and Arabian bats. There was not a subject in natural history that was not only represented, but well represented. We're talking about a collection of carefully selected books which exceeded 1,000 running feet of shelf space.

Class members soon learned that it was quicker to visit he Worthley's than to go to the library. Parking was easier, and Dr. Worthley would find the reference you wanted and a number of others you didn't realize you needed. If he was in the mood, you and anyone else in the house would get a spontaneous lecture on whatever your topic might be, during the course of

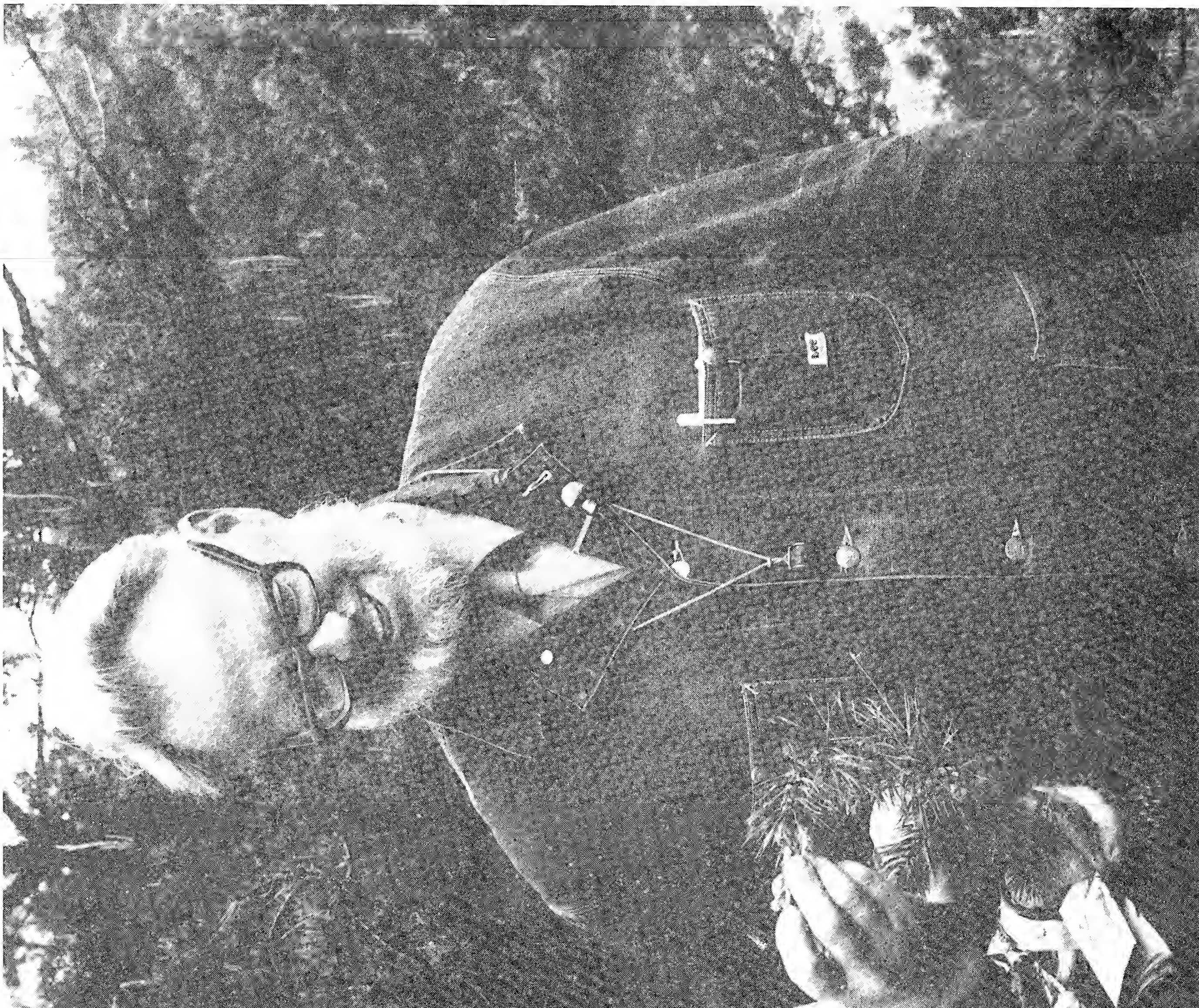
which he would think of half a dozen other books you needed to see. He would insist you take them home, but on the way out the door he would rattle off about how Charley Stine ruined his precious volume of something or other (the title changed with the occasion) when snow came into the back of Charley's blue 1952 station wagon. The message was clear, take care of his books or become a negative anecdote.

One might logically inquire how, with all this enthusiasm for the scholarly pursuits of others, Elmer ever found time for anything else. It's a good question and one which suggests excuses for his almost never being on time. On the other hard, since he never wore a watch or committed to specific times or deadlines, he could counter that he was seldom really late.

My first exposure to Dr. Worthley was a lecture that he gave at the Maryland Ornithological Society in 1970. He was on time. The lecture was on warblers. Well, actually it was on wood warblers. The first thing we learned was the difference between Old World warblers and the New World wood warblers. I was prepared for a typical bird lecture on how you tell species A from species B. It promised to be a long evening. Elmer's lecture, however, was on the ecological stratification of native warblers. The subject was covered in detail. It was great, and it was my first indication that birds were really interesting, and not just something to be checked off on a list. I did not realize it at the time, but that lecture changed my perspective on birds and over the next decade I grew less and less interested in reptiles and focused my attention on ornithology. Elmer liked birds too, and while he considered himself a botanist, at botanical meetings he would tell people he was an ornithologist. Conversely, on Maryland Ornithological Society field trips (at one time he was president of that organization) he lectured on grasses. In truth, he was well versed in both disciplines.

One spring he led our class on a field trip to the north end of Assateague Island. The place was still wild then. The first night we ate a bushel or two of soft-shell clams, drank cold beer and told stories into the night. The next morning the class officially started. We planned to transect the island at a narrow point. Creeping through the intertidal zone on the beach side, notebooks in hand, we began to record everything we came across, pausing for an anecdotal story or two about every object. By Saturday evening, when the class broke for the second campfire and what remained of the beer, we had just reached the back of the first dune. By Sunday afternoon, when everyone left for home, we were still on the second dune, with the majority of our island transect yet to be explored. Still, it was fun and we knew we would return. That was the first weekend in June of 1974. I know because I still have my notes, and I suspect the rest of the class members do too.

Unrelated to the class, but always somehow tied to botany, Elmer and I went on various extended field trips. Together we explored several (then) remote parts of Florida, the Baja peninsula and southeast Arizona. The first field trip did not exactly go as I expected. We were to leave at 8 a.m. After carefully packing my car I was informed that we would take Elmer's van. We repacked, correction, I repacked while Elmer looked up things in the books we couldn't take with us and made copious notes on little slips of paper. We were ready to go by 2:00 or 3:00 in the afternoon. Then he handed me the keys. "But I never drove a standard shift vehicle", I protested. "That's OK, you'll learn my boy." He was right, I did, his teaching methods even worked for driver's ed, but the Baltimore Beltway would not have been my first choice for practice. I'm glad he didn't teach me to swim.



At any rate, it was a great trip and, as always, I learned a lot. Somewhere in the Florida panhandle Elmer collected a bag of moss. He always focused on the "lesser" plants. The more obscure it was the more likely it would command Elmer's attention. This moss, however, was alive with chiggers and Elmer's infestation was the worst I had ever seen. He was miserable, and itched and scratched and wiggled, but continued to botanize. Later in the day he purchased a drop cord, a sixty watt bulb, and a half dozen paper-back books. All night he read western fiction, and when he realized that the light in the van was not keeping me awake he started to read parts out loud. I have not liked Zane Grey since, and on future trips always took my own car. Somehow that gave me the false impression that I had some control.

Dr. Worthley traveled widely. His botanical expertise was used by the military all over the world. He also took extended vacations to interesting places (the Amazon, Antarctica, Australia, various Caribbean Islands, the Philippines, etc.). The knowledge and insights gained on those trips were put to use in his teaching. A mountain in Antarctica was named for him in 1959 (a beetle bearing his name is also soon to be described). In my mind that mountain stands as a remote, inspirational tribute to the explorations, both geographical and mental, of the most interesting person I have ever met. Still, while Antarctica would be fun to visit, I have no interest in seeing Elmer's mountain. It probably wouldn't live up to my expectations.

Even though Elmer was widely traveled, his real contribution was to local natural history. While Elmer provided much support for local conservation efforts, he was not one to jump onto environmental band-wagons. Even when forced into situations where he was expected to work on environmental issues he would somehow avoid them. In 1981 Butch Norden talked Elmer into presenting a talk on the rare and endangered plants of serpentine barrens, at an endangered species symposium held at Towson State University. Elmer showed up on time and was introduced to the audience. The title of his talk was on everyone's program but Elmer decided that he would give a lecture on the mosses of Maryland instead. I later asked him about this. "Hell! By definition half the plants at any one place are rarer that the other half. Some plants always were rare and always should be. To make them otherwise would mean altering habitat. That would make the common ones rare and endangered." Elmer aimed his sights in the right direction, toward habitat conservation. He was successful in this too. His approach was not direct and militant, he simply educated influential people.

For much of his professional life, Elmer worked for the military in a civilian role. What got him out of bed in the morning was his desire to try his creative efforts on newly schemed ways to harass bureaucratic administrators. An inability to understand science or scientists seems an inherent part of bureaucratic administration. Elmer's ability to keep this fundamental problem in focus was an art form. His government expense accounts were always returned covered with notes about missing receipts. "How did they expect me to keep an itinerary and an expense account?" he would ask. "We were 30 or 40 miles up some unknown tributary of the Amazon. Villages were unnamed, and we paid for our provisions with blankets and empty coffee cans. How could I get a receipt when the people couldn't read or write?" He once responded to such a request by writing in the margin, "Friday PM dinner monkey chowder, cost one plastic comb. Cost to monkey considerably more." Elmer was an administrator's nightmare. While working at Edgewood Arsenal he outlived one of his supervisors, and retired several others. "Buried 'em in their own damn paperwork," he boasted. He left all this behind in 1981 when he retired and turned his total attention to his class.

When you write something like this it seems obligatory to spell out all the milestone facts, dates of birth, schooling and the like. In the 20 years that I knew him, Elmer never boasted of, or even acknowledged, milestones or personal accomplishments, so it seems unfitting to list them here. This was a man who would not remember his own birthday, and a father who was in Antarctica at the time his first daughter was born. It was not that he didn't care about these things, it was his total commitment to his scientific pursuits that kept him off-balance. There were always so many books to study, places to go, and piles of specimens to poke through.

Elmer was a stickler for accuracy. He thought nothing of interrupting someone else's lecture to educate them on a fine point of botanical nomenclature or to correct an erroneous statement. Like Alice, he would not allow the interchange or turtle and tortoise to pass unchallenged.

Some students may say that what they remember most about Elmer is what he taught them, but I suspect that most remember him more that what he taught. What I remember is a really fine friend with whom I could share experiences and drink a beer or two. What he taught me was not the endless barrage of biological facts that always poured forth, but rather that there is more to a warbler, or a goldenrod, than its name.

On the evening of 19 June 1991 Dr. Elmer George Worthley died of cancer. His plant taxonomy class was in the next room talking about plants they had seen on the previous Wednesday evening field trip. (It was class number 1,299 by my calculations, but this does not include several hundred field trips. In contrast MASH had only 251 televised episodes). During the previous days and months he had lived with much pain and frustration, but his spirits and humor remained high, his mind strong, and his love of nature very much intact. "My boy, first they take out this, and then they take out that and soon there is nothing left." Elmer studied the effects of the disease with the same matter-of-factness he applied to plant taxonomy.

Elmer Worthley is survived by a loving family, which includes a very accomplished spouse, and children that, even by Elmer's standards (but not by his admission), are admirable. Some of the children bear the names of favorite botanists or plants. The family also includes Aurora, an Orange-winged Amazon parrot that Elmer bought from a Chama Indian for 75 cents on a trip to the Amazon in 1962. Elmer also has an extended family of students and fellow naturalists. Many of them still get together on occasion to study a book, drink a beer, or discuss plant taxonomy. The botany class, by-the-way, is still in session and meets every Saturday at the Oregon Ridge Nature Center. Things start at 9:00 AM. Bring a treat for the parrot. Field trips to be announced.

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Discovery Of An Endangered Maryland Fish, The Glassy Darter, *Etheostoma vitreum* (Cope), On The Delmarva Peninsula, Maryland*

Stephen P. McIninch, Charles H. Hocutt and Roman V. Jesien

Introduction

The glassy darter *Etheostoma vitreum* was first described by Edward Drinker Cope in 1879 from a tributary of the Neuse River in North Carolina. Being a highly specialized member of its genus, it has been placed in its own monotypic subgenus, *Ioa* (Jenkins 1971, Page 1983). It is a relatively small darter (standard length rarely exceeding 60 mm) with a pointed snout, fleshy villi around the anus, large pectoral fins, and a rather translucent body from which the common name is derived (Figure 1). The glassy darter generally inhabits small to moderate sized streams and rivers with moderate to fast currents flowing over clean sand.

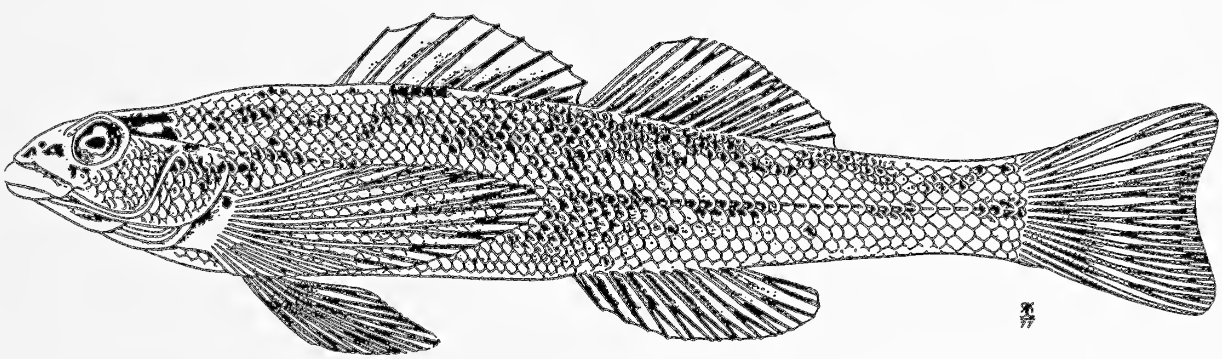

Figure 1. The glassy darter, *Etheostoma vitreum*. Reproduced with permission of North Carolina State Museum of Natural Sciences.

In Maryland, the glassy darter is known from only a few localities (Figure 2). The Patuxent River drainage is often considered the northern extent of its range but a record does exist from Winter's Run in the Bush River drainage north of Baltimore (Lee et al. 1980). Due to a lack of recent captures from areas where populations were known to have existed the glassy darter has been listed as highly rare/extirpated in Maryland by the Maryland Natural Heritage Program (1988. Rare, threatened & endangered animals of Maryland. MD Natural Heritage Program) and was considered threatened by Lee et al. (1984).

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* UMCEES Contribution No. 2274

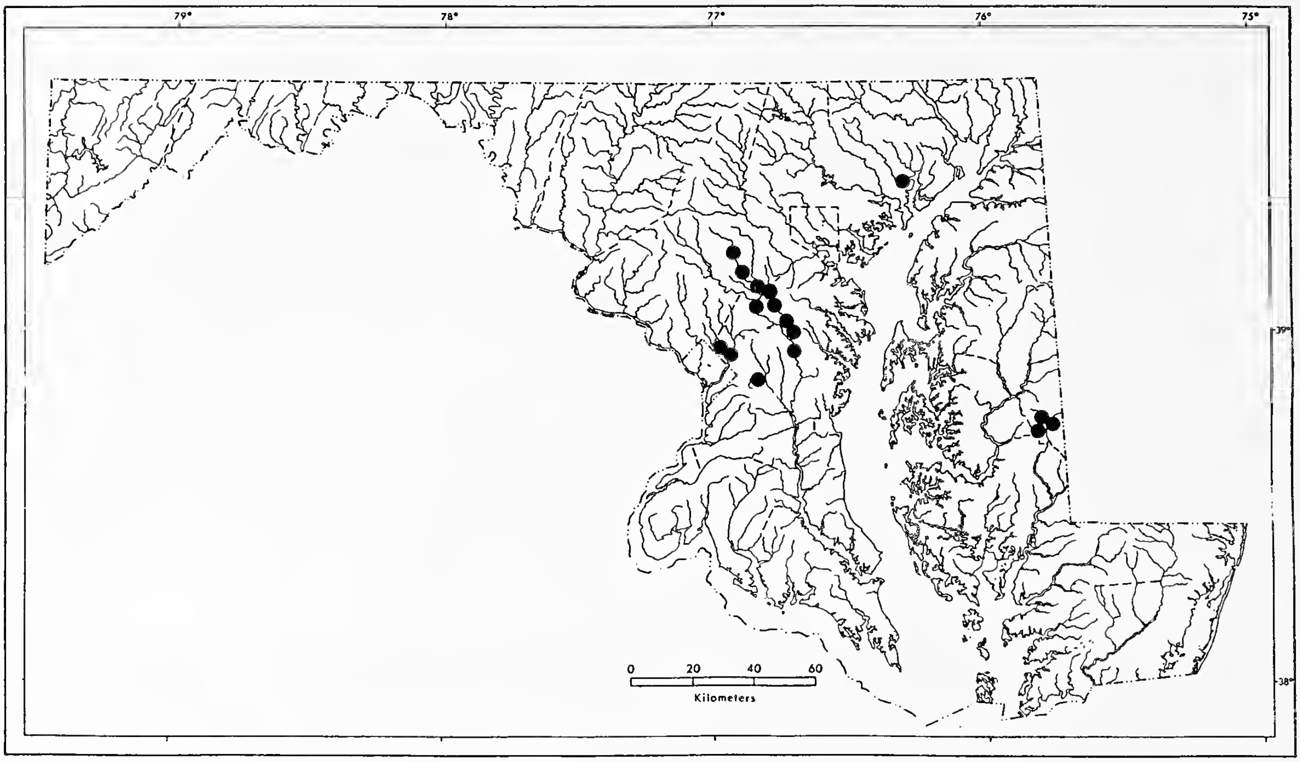

Figure 2. Known localities for the glassy darter in Maryland (●), modified from Lee et al. (1984). Map reproduced with permission of North Carolina State Museum of Natural Sciences.

An interesting aspect of the life of *Etheostoma vitreum* is its ability and tendency to bury into the sand. It appears that the large majority of the day is spent buried, with occasional excursions on top of the sand to forage at dawn and dusk (Winn and Picciolo 1960, personal observations). This behavior may help to avoid predation by larger fish and piscivorous birds. We have observed a sympatric, similar species, the tessellated darter, *Etheostoma olmstedi*, also buried in the sand within close proximity to the glassy darter. In one instance, single specimens of both species were probed from the sand of a stream approximately 3 cm apart from each other. This tendency of the tessellated darter to bury may be important in the partitioning of microhabitat between these two species. The interactions between these two darters are not well known and warrant further study.

Distribution

The glassy darter occurs on the Atlantic slope from the Neuse River drainage in North Carolina to the Bush River in Maryland (Lee et al. 1980), and is reported as locally common in much of its range (Page 1983). Historically, *Etheostoma vitreum* was common in some areas of Maryland (Winn and Picciolo 1960) but generally confined to a small part of the lower Potomac and Patuxent River drainages (Figure 2). Owing to the lack of recent records from Maryland, the glassy darter was suspected to be extirpated in the state. This may be due to its limited range and the proximity of the range to heavily urbanized areas (Lee et al. 1981).

Biology

The glassy darter is very cryptic in appearance and habit. The common name reflects the rather translucent nature of its body. Some brown to black speckling exists on the body and fins, and aids in its natural camouflage. Two closely related darters of the subgenus *Boleosoma*, the johnny darter *(Etheostoma nigrum)* and the tessellated darter, have a somewhat similar appearance, and are believed to be fairly closely related (Simons in press). These darters, however, are more opaque in life, their speckling or markings are better developed, and they do not possess the pointed snout or fleshy villi of the glassy darter. *Etheostoma vitreum* is also separated from similar darters by its reproductive behavior and condition. Both sexes of the glassy darter develop breeding tubercles on the pectoral and pelvic fins (Jenkins 1971). Spawning occurs in the early spring and is communal in nature. The communal spawning may be advantageous to these darters, which have relatively low fecundity (Winn and Picciolo 1960).

Rediscovery

On 8 September 1990, a single male specimen of *Etheostoma vitreum* was collected from Tull Branch at Smithville Road, a tributary of Marshyhope Creek in Caroline County, Maryland, approximately 2.3 airkm NNE of Federalsburg. This record constitutes the first specimen of the glassy darter collected on the Delmarva Peninsula.

Subsequent sampling efforts have revealed other populations on the Delmarva Peninsula (Figure 2), close to the Tull Branch locality, in Faulkner Branch at Rte 630, Caroline Co., Maryland; lower Twiford Meadow Branch in Idylwild Wildlife Demonstration Area, Caroline Co., MD; and from Marshyhope Creek proper at sites within Idylwild Wildlife Demonstration Area, Caroline Co., MD. In addition, glassy darters have been recently collected in moderate numbers from the Little Patuxent River outside Fort George Meade in Anne Arundel Co. (Steve Fisher, Wye Institute, personal communication; personal observation).

Snorkeling observations from the Faulkner Branch locality revealed 20 glassy darters in a stretch of stream approximately 100 meters long. Of these, only one was on top of the sand when identified. The remainder were probed from beneath the sand using a stick. As stated above, this burying behavior is quite common and careful sampling methods should be used when searching for these darters.

Summary

The historical populations of the glassy darter in the Bush, Potomac, and Patuxent River drainages may be depleted or extirpated, due at least in part to urbanization and water quality degradation. A recent trip to Western Branch near Largo, Prince George's Co., MD (site reported by Winn and Picciolo 1960) yielded no glassy darters. Although sand was the dominant substrate type, the stream had been channelized and much of the sand was silted over, habitat diversity was low and fishes were uncommon. A thorough search is underway in order to determine the status of this darter in Maryland. The glassy darter's habitat of clean sand in clear flowing freshwater,

although present in both Maryland and Delaware, is not abundant on the Delmarva Peninsula, therefore the populations of glassy darter should be monitored carefully.

Acknowledgements

We thank Scott E. Seibold and Joe Serafy for their assistance in surveying for the glassy darter, Janet McKegg and the MD Natural Heritage Program for information regarding the status of the glassy darter, and Carter Gilbert, Robert Jenkins, David Lee, and Arnold Norden for their comments on the manuscript. We also thank Steve Fisher and Lenwood Hall for their recent glassy darter records.

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An Annotated List Of The Ferns And Fern Allies Of Maryland And The District of Columbia

Donnell E. Redman

Introduction

Dr. Clyde F. Reed published *The Ferns and Fern-Allies of Maryland and Delaware, Including the District of Columbia* in 1953. Since that time, almost 40 years ago, research in genetics and taxonomy has brought about considerable change in our understanding of the interrelationships and speciation characteristics of many of our state's pteridophytes. During my 20 years of studying ferns it has become clear that Dr. Reed's guide has become outdated due to the above changes, changes in nomenclature, new discoveries within the state, and human induced changes in the local distribution of various species.

Scientific accuracy in our knowledge of plant species and their distribution has become of increasing importance in recent years due to environmental regulations. Wetland assessments, forest assessments, and endangered species laws require that the identification and distribution of known taxa be accurate. In fact, state rare species regulations presently protect specific taxa but exempt protection for non-specific taxa.

With this in mind, this author has embarked on a project to prepare a new fern guide for Maryland to update information on the state's ferns and fern allies and to correct errors and misconceptions now in print. It will also provide detailed ecological and distributional data which, it is hoped, will provide other environmental scientists with current information to help protect this interesting part of our flora. The following is a preliminary list of taxa to be covered by the upcoming guide, and summarizes each taxa's current (extant) distribution as it is known to me. Nomenclature follows Lellinger (1985).

The author welcomes comments on this list, and suggestions which would make the fern guide of greater use to readers. A map (Figure 1) showing the location of counties, Baltimore City and the District of Columbia (D.C.) is included as a convenience.

Species Checklist

- *Adiantum pedatum* L. subsp. *pedatum* [Northern Maidenhair]. Occurs in Maryland as both a diploid and a tetraploid. Common in moist, rocky woods in all counties above the Fall Line and D.C., and Charles, Prince George's, St. Mary's, and Talbot Counties on the Coastal Plain.

- *Asplenium bradleyi* D. C. Eaton [Bradley's Spleenwort]. Occurs in Maryland as a sterile diploid hybrid (*A. montanum* x *platyneuron*) and as a tetraploid species. Rare in shaded crevices of acidic rocks in Baltimore and Harford Counties.

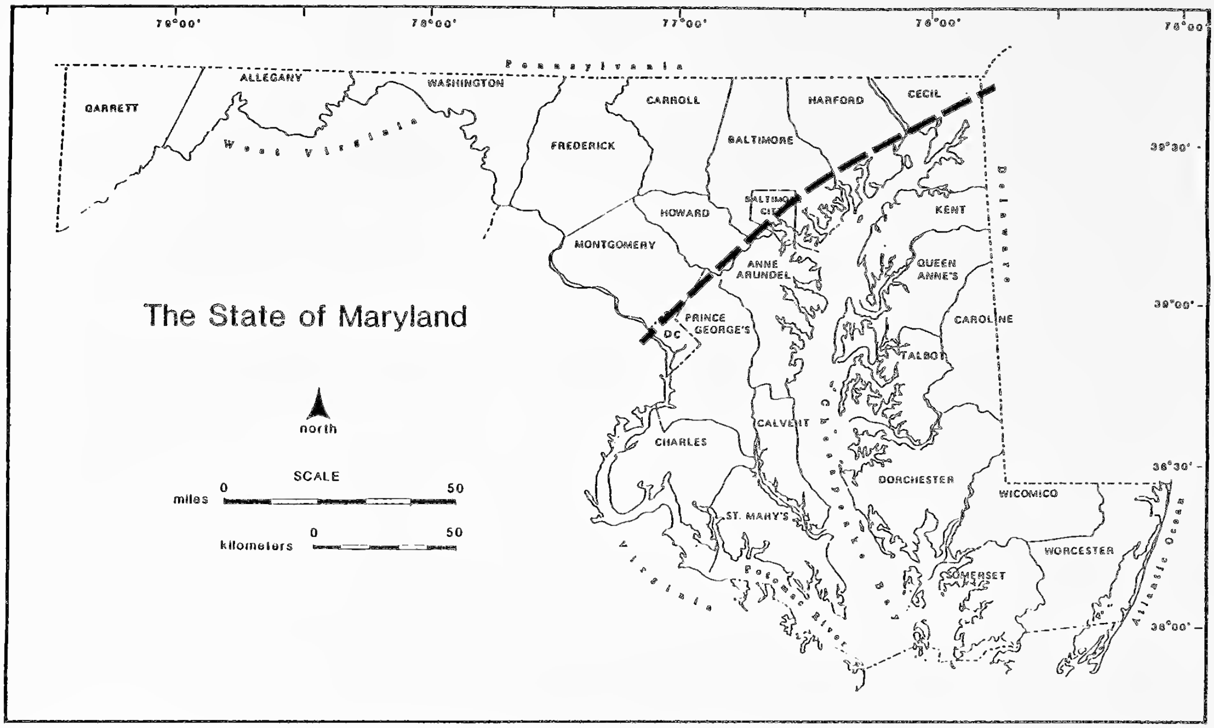

Figure 1. Map of Maryland showing location of counties, Baltimore city and the District of Columbia (D.C.). Also shown is the approximate location of the Fall Line, which separates the Coastal Plain from the Piedmont Province.

- *Asplenium* x *ebenoides* R.R. Scott (*Asplenium platyneuron* x *rhizophyllum*) [Scott's Spleenwort]. This is a sterile diploid hybrid in Maryland, but has one fertile tetraploid population in Alabama. Rare on shaded limestone in Washington County.

- *Asplenium* x *morganii* W. Wagner (*A. platyneuron* x *A. ruta-muraria*) [Morgan's Spleenwort]. This is a very rare triploid sterile hybrid. One station known, the type station on shaded limestone in Washington County.

- *Asplenium montanum* Willd. [Mountain Spleenwort]. Occasional on open or lightly shaded acidic rocks in Allegany, Baltimore, Frederick, Garrett, Harford, Montgomery, and Washington Counties.

- *Asplenium pinnatifidum* Muhl. [Lobed Spleenwort]. Occurs as a sterile diploid hybrid (*A. montanum* x *rhizophyllum*) and as a tetraploid species. Rare on shaded acidic rocks in Baltimore, Frederick, and Washington Counties.

- *Asplenium platyneuron* (L.) B.S.P. [Ebony Spleenwort]. Abundant in both epipetric and terrestrial situations on acidic and, less often, calcareous substrates, in sun or shade in every county, Baltimore City, and D.C.

- *Asplenium resiliens* Kunze [Black-stemmed Spleenwort]. This is an apogamous triploid hybrid which reproduces asexually by unreduced megaspores. Rare on shaded limestone ledges in Washington County.

- *Asplenium rhizophyllum* L. [Walking Fern]. Frequent as an epipetric on shaded limestone rocks in Washington County, and occasional on various rock types in Allegany, Baltimore, Frederick, Garrett, Harford, and Washington Counties.

- *Asplenium ruta-muraria* L. [Wall-rue]. Infrequent and local as an epipetric on shaded limestone rocks (one station on a bridge abutment) in the Potomac River drainage of Allegany, Frederick, Montgomery, and Washington Counties.

- *Asplenium trichomanes* L. [Maidenhair Spleenwort]. Occurs as diploid and triploid subspecies, and their sterile hybrid. Frequent as an epipetric on moist, shaded limestone or calcareous shale rocks, and infrequent on sandstone rocks. All counties above the Fall Line except Cecil County. *Asplenium trichomanes* ssp. *trichomanes* L. is a diploid preferring non-calcareous rocks. *Asplenium trichomanes* ssp. *quadrivalens* D. E. Meyer emend Lovis., is an allotetraploid usually found on calcareous rocks. The triploid hybrid between the two subspecies has been found in West Virginia, but has not yet been collected in Maryland.

- *Asplenium* x *trudellii* Wherry (*Asplenium montanum* x *pinnatifidum*) [Trudell's Spleenwort]. This is a sterile triploid hybrid which is possibly apogamous. Rare on shaded limestone rocks in Washington County.

- *Athyrium filix-femina* subsp. *angustum* (Willd.) Clausen [Northern Lady Fern]. Abundant in moist woods, thickets, and forested wetlands in all counties and D.C.

- *Athyrium filix-femina* subsp. *aspleniodes* (Michx.) Hulten [Southern Lady Fern]. Abundant in moist woods, thickets, and forested wetlands in all counties, Baltimore City, and D.C.

- *Athyrium pycnocarpon* (Spreng.) Tidestr. [Narrow-leaved Glade Fern]. Rare on forested floodplain terraces in Baltimore, Harford, and Washington Counties.

- *Athyrium thelypteroides* (Michx.) Desv. [Silvery Glade Fern]. Frequent in moist rich woods in all counties, Baltimore City, and D.C. above the fall line, and rare in Anne Arundel, Calvert, Prince George's, Talbot, and Worcester Counties on the Coastal Plain.

- *Azolla caroliniana* Willd. [Eastern Mosquito Fern]. Local in streams draining fish hatchery areas on limestone strata of southern Frederick County.

- *Botrychium dissectum* Spreng. [Lace-frond Grape Fern]. Abundant in woods, thickets, and overgrown fields in all counties and D.C.

- *Botrychium matricariifolium* A. Braun [Daisy-leaved Moonwort]. Rare on rich soils in thickets and shaded woods in Anne Arundel, Howard, Montgomery, and Prince George's Counties, and in meadows in Garrett County.

- *Botrychium multifidum* (Gmel.) Rupr. [Leathery Grape Fern]. Very rare, known only from one station in a briar thicket in northern Baltimore County.

- *Botrychium oneidense* (Gilb.) House [Blunt-lobed Grape Fern]. Rare in swampy woods in St. Mary's and Dorchester Counties.

- *Botrychium virginianum* (L.) Swartz [Rattlesnake Fern]. Common throughout the state in moist woods and occasional in thickets, all counties, Baltimore City, and D.C.

- *Cheilanthes lanosa* (Michx.) D.C. Eaton [Hairy Lip Fern]. Infrequent on non-calcareous rocks in Allegany, Baltimore, Cecil, Frederick, Harford, Howard, Montgomery and Washington Counties.

- *Cystopteris bulbifera* (L.) Bernh. [Bulblet Fern]. Locally common on limestone along the Potomac River in Washington County.

- *Cystopteris fragilis* (L.) Bernh. [Brittle Fern]. This is a tetraploid species. Occasional as an epipetric on rocks and cliffs in Allegany and Garrett Counties.

- *Cystopteris protrusa* (Weath.) Blasdell [Lowland Brittle Fern]. Frequent in mesic woods and on floodplains in all counties above the Fall Line, and D.C.

- *Cystopteris tennesseensis* Shaver [Tennessee Bladder Fern]. This is a tetraploid species. Very rare, known only from one extant station on a man-made wall in a forest in central Harford County.

- *Cystopteris tenuis* (Michx.) Desv. [Mackay's Brittle Fern]. This is a tetraploid species. Common as an epipetric and infrequent as a terrestrial in woods in all counties above the Fall Line, and D.C.

- *Dennstaedtia punctilobula* (Michx.) Moore [Hayscented Fern]. Abundant in acid soils of open woods, on rocky slopes, and in upland meadows in all counties, Baltimore City, and D. C. west of the Chesapeake Bay, and occasional in damp sandy woods on the Eastern Shore.

- *Dryopteris* x *australis* (Wherry) Small (*Dryopteris celsa* x *ludoviciana*) [Southern Swamp Fern]. This is a sterile triploid hybrid. Very rare, known only from one station in a swamp in western Baltimore County.

- *Dryopteris* x *boottii* (Tuckerm.) Underw. (*Dryopteris cristata* x *intermedia*) [Boott's Woodfern]. This is a sterile triploid hybrid which reproduces apogamously. Infrequent in swamps or on wooded streambanks in Anne Arundel, Baltimore and Garrett Counties.

- *Dryopteris campyloptera* Clarkson [Mountain Woodfern]. This is a tetraploid species. Rare at two stations in open rocky woods on mountain summits in Garrett County.

- *Dryopteris campyloptera* x *intermedia* [Intermediate Mountain Woodfern Hybrid]. This is a sterile triploid hybrid. One station on a mountain summit bald in southern Garrett County.

- *Dryopteris carthusiana* (Villars) H.P. Fuchs [Spinulose Woodfern]. This is a tetraploid species. Common in central Maryland, frequent west of Frederick County, and occasional on the Eastern Shore in moist woods and swamps.

- *Dryopteris celsa* (W. Palmer) Small [Log Fern]. Occurs as a sterile diploid and as a tetraploid species. Infrequent as mostly small colonies in swamps, along wooded streambanks and on rocky seepage slopes. Extant populations are in Anne Arundel, Baltimore, Cecil, Frederick, Harford, Howard, Somerset, Talbot, and Worcester Counties. This species has been frequently confused with *Dryopteris clintoniana* (D.C. Eaton) Dowell [Clinton's Woodfern], a hexaploid species which does not occur in Maryland.

- *Dryopteris celsa* x *cristata* [Crested Log Fern Hybrid]. This is a sterile tetraploid hybrid. Very rare, known only from two stations, in Harford and Howard Counties.

- *Dryopteris cristata* (L.) A. Gray [Crested Woodfern]. This is a tetraploid species. Frequent in swamps in Anne Arundel, Baltimore, Cecil, Charles, Garrett, Harford, Howard, Kent, Montgomery, Prince George's, Talbot, and Wicomico Counties.

- *Dryopteris goldiana* (Hooker) A. Gray [Goldie's Wood Fern]. Rare on floodplain terraces and in rich rocky woods in Baltimore, Frederick, Garrett, and Harford Counties.

- *Dryopteris intermedia* (Muhl.) A. Gray [Fancy Fern]. Abundant in Garrett County, common in all other counties above the Fall Line, and rare on the Coastal Plain in moist, often rocky woods.

- *Dryopteris* x *leedsii* Wherry (*Dryopteris celsa* x *marginalis*) [Leeds' Wood Fern]. This is a sterile triploid hybrid. Rare in forested seeps in Frederick and Harford Counties.

- *Dryopteris marginalis* (L.) A. Gray [Marginal Wood Fern]. Common in rocky woods of all counties above the Fall Line, infrequent on the Coastal Plain along swamp borders.

- *Dryopteris* x *separabilis* Small (*Dryopteris celsa* x *intermedia*) [Glandular Log Fern Hybrid]. This is a sterile triploid hybrid. Rare in Frederick and Harford Counties.

- *Dryopteris* x *slossoniae* Wherry ex Lellinger (*Dryopteris marginalis* x *cristata*) [Miss Slosson's Woodfern]. This is a sterile triploid hybrid. Very rare, known only from two stations, a swamp in Baltimore County and a stream bank in Montgomery County.

- *Dryopteris* x *triploidea* Wherry (*Dryopteris carthusiana* x *intermedia*) [Fruity Wood Fern]. This is a sterile triploid hybrid that reproduces asexually by unreduced megaspores. Common in all counties above the Fall Line and occasional on the Coastal Plain.

- *Dryopteris* x *uliginosa* Druce (*Dryopteris cristata* x *spinulosa*) [Druce's Wood Fern]. This is a sterile tetraploid hybrid. Two stations in swamps in Anne Arundel County.

- *Equisetum arvense* L. [Common Horsetail]. Abundant in disturbed sandy or, less often, clay soils, in open woods, meadows, and along streambanks, roadsides and railroad tracks. All counties, Baltimore City, and D.C.

- *Equisetum* x *ferrissii* Clute (*E. hyemale* var. *affine* x *laevigatum*) [Ferriss' Scouring Rush]. This is a sterile diploid hybrid. One station in Prince George's County, along the Potomac River south of D.C.

- *Equisetum fluviatile* L. [Water Horsetail]. Very rare, known only from one station along the bank of a creek in Cecil County.

- *Equisetum hyemale* var. *affine* (Englem.) A. A. Eaton [Tall Horsetail]. Frequent in sandy woods and on alluvial flats. In all counties and D.C., except Dorchester, Somerset, Wicomico, and Worcester.

- *Equisetum sylvaticum* L. [Wood Horsetail]. Rare in damp forests bordering swamps in Garrett County.

- *Gymnocarpium dryopteris* (L.) Newm. [Oak Fern]. Very rare, known only from one extant station on the bank of a cold stream in Garrett County.

- *Isoëtes engelmanni* A. Braun [Engelmann's Quillwort]. Occasional as an amphibious herb in Cecil, Charles, Frederick, Garrett, Montgomery, and Prince George's Counties.

- *Isoëtes riparia* Engelmann ex A. Braun [Shore Quillwort]. Frequent as an amphibious herb in Baltimore, Caroline, Cecil, Dorchester, Harford, Queen Anne's and Wicomico Counties.

- *Lycopodium alopecuroides* L. [Foxtail Club-moss]. Occasional in swampy pine woods in Wicomico and Worcester Counties.

- *Lycopodium annotinum* L. [Stiff Club-moss]. Occasional in damp rocky forests on mountain slopes in Garrett County.

- *Lycopodium appressum* (Chapman) Lloyd & Underw. [Southern Club-moss]. Occasional in bogs, sand barrens, and along shores in Anne Arundel, Dorchester, Howard, Kent, Prince George's, Wicomico, and Worcester Counties.

- *Lycopodium carolinianum* L. [Slender Club-moss]. Very rare, known only from one station in open, wet pinewoods in Worcester County.

- *Lycopodium clavatum* L. [Running Club-moss]. Frequent in open sandy woods of Garrett County, occasional in open sandy woods of Anne Arundel, Baltimore, Cecil, Harford, Montgomery, and Prince George's Counties.

- *Lycopodium dendroideum* Michx. [Round-branch Ground-pine]. Occasional in mesic woods on loamy soils in Anne Arundel, Frederick, Howard, and Prince George's Counties.

- *Lycopodium digitatum* Dillen. ex A. Braun [Fan Club-moss]. Common in dry woods, abandoned fields, and occasional on open slopes in all counties and D.C.

- *Lycopodium hickeyi* W. H. Wagner, Beitel and Moran [Hickey's Ground-pine]. Distribution not completely understood in Maryland, but currently known from dry sandy woods in Allegany and Washington Counties.

- *Lycopodium inundatum* L. [Bog Club-moss]. Rare in bogs in Garrett County.

- *Lycopodium lucidulum* Michx. [Shining Club-moss]. Common above the Fall Line in damp or wet woods in rich humus soils, and occasional on the Coastal Plain in forested wetlands. Known from all counties except Calvert, Charles, Dorchester, and St. Mary's.

- *Lycopodium obscurum* L. [Flat-branch Ground-pine]. Common in mesic woods on loamy soils in all Maryland Counties.

- *Lycopodium tristachyum* Pursh [Ground-cedar]. Rare in sandy woods in Garrett, Wicomico, and Worcester Counties.

- *Lygodium palmatum* (Bernh.) Swartz [American Climbing Fern]. Rare, in large colonies on sandy soils of wet deciduous/evergreen forests of Anne Arundel, Calvert, and Prince George's Counties.

- *Matteuccia struthiopteris* var. *pensylvanica* (Willd.) Morton [Ostrich Fern]. Infrequent in colonies in floodplain forests of Allegany, Baltimore, Carroll, Harford, Montgomery and Washington, Counties. Also introduced at two sites in Garrett County.

- *Onoclea sensibilis* L. [Sensitive Fern]. Abundant and invasive in forested and non-forested wetlands, moist fields, and thickets in all counties, Baltimore City, and D.C.

- *Ophioglossum pusillum* Raf. [Northern Adder's-tongue]. Infrequent in grassy swales, wet thickets, and floodplains, usually with acid soils, in Cecil County.

- *Ophioglossum pycnostichum* (Fern.) Löve and Löve [Southeastern Adder's-tongue]. Frequent in floodplain woods on circumneutral soils in Baltimore, Cecil, Dorchester, Harford, Montgomery, Prince George's, St. Mary's, Talbot, Wicomico, and Worcester Counties. Rare on floodplains in Carroll, Frederick, and Washington Counties.

- *Osmunda cinnamomea* L. [Cinnamon Fern]. Abundant in forested wetlands, and occasional in non-forested wetlands in all counties and D. C.

- *Osmunda claytoniana* L. [Interrupted Fern]. Common in forests on loamy soils of high humus content in all counties, Baltimore City, and D.C. above the Fall Line, abundant in Garrett County, and rare on the Coastal Plain in Anne Arundel, Cecil, Prince George's, and Queen Anne's Counties.

- *Osmunda regalis* var. *spectabilis* (Willd.) A. Gray [Royal Fern]. Forested wetlands in all counties and D.C. Common on the Coastal Plain, frequent in the Piedmont, and occasional west of Frederick County.

- *Pellaea* x *atropurpurea* (L.) Link (*P. glabella* x *ternifolia*) [Purple Cliff-brake]. This is an apogamous triploid hybrid that reproduces asexually by unreduced megaspores. Occasional as an epipetric in crevices of limestone outcrops and in mortar of limestone walls in Allegany, Baltimore, Frederick, Montgomery, and Washington Counties.

- *Pellaea glabella* Mett. ex Kuhn [Smooth Cliff-brake]. Occurs as a diploid species in Missouri, and an apogamous tetraploid species in Maryland and elsewhere. Rare on limestone cliffs in Frederick, Montgomery, and Washington Counties.

- *Polypodium appalachianum* Haufler & Windham [Appalachian Rock Polypody]. Abundance in Maryland not yet known, but stations have been located on cliffs and rocky slopes in Garrett County.

- *Polypodium appalachianum* x *virginianum* [Rock Polypody Hybrid]. This is a triploid hybrid which may reproduce apogamously. Not yet known from this state, but occurs in West Virginia south of Allegany County, Maryland.

- *Polypodium polypodioides* var. *michauxianum* Weath. [Resurrection Fern]. Occasional as an epiphytic on tree trunks in the Pocomoke River drainage of Wicomico and Worcester Counties.

- *Polypodium virginianum* L. [Common Rock Polypody]. This is a tetraploid species. Common as an epipetric, and infrequent as an epiphytic or as a terrestrial above the Fall Line, and infrequent in the same habitats in Anne Arundel, Caroline, Cecil, Harford, Prince George's, Queen Anne's, and Wicomico Counties on the Coastal Plain.

- *Polystichum acrostichoides* (Michx.) Schott [Christmas Fern]. Abundant in woodlands, on open rocky slopes, and in thickets in all counties, Baltimore City, and D.C. This is our most common fern species.

- *Pteridium aquilinum* var. *latiusculum* (Desv.) Underw. [Eastern Bracken]. Abundant in open woodlands (particularly pine woods), thickets, barrens, and pastures, preferring light acid sandy soils. Occurs in every county and D.C.

- *Pteridium aquilinum* var. *pseudocaudatum* (Clute) Heller [Tailed Bracken]. Common in barrens and open pine or oak woods. Restricted to the Coastal Plain of Anne Arundel, Caroline, Calvert, Charles, Dorchester, Prince George's, St. Mary's, Somerset, Wicomico, and Worcester Counties.

- *Selaginella apoda* (L.) Spring [Meadow Spike-moss]. Frequent in damp areas of woodlands, meadows, rocks, rotting logs, and lawns.

- *Selaginella rupestris* (L.) Spring [Rock Spike-moss]. Infrequent as an epipetric on exposed rocks, usually non-calcareous or on shales. Stations in Allegany, Baltimore, Frederick, Montgomery, and Washington Counties.

- *Thelypteris hexagonoptera* (Michx.) Weath. [Broad Beech Fern]. Common on forested slopes in all counties and D.C. above the Fall Line, infrequent on the Coastal Plain, and absent from Caroline, Dorchester, Somerset, Wicomico, and Worcester Counties.

- *Thelypteris noveboracensis* (L.) Nieuwl. [New York Fern]. Abundant in woods and swamps in rich subacid soils in all counties and D.C.

- *Thelypteris palustris* var. *pubescans* (Laws.) Fern. [Marsh Fern]. Common in wetlands, both open and forested, in all Coastal Plain counties, frequent in the Piedmont, infrequent in the mountains, and absent from limestone areas.

- *Thelypteris phegopteris* (L.) Slosson [Long Beech Fern]. This is a sterile triploid that reproduces asexually by unreduced megaspores. Rare as an epipetric in shaded rock crevices in Allegany and Garrett Counties.

- *Thelypteris simulata* (Davenp.) Nieuwl. [Bog Fern]. Rare in sphagnum bogs and swamps in Anne Arundel, Baltimore, Garrett, Harford, Prince George's, Talbot, and Wicomico Counties.

- *Woodsia ilvensis* (L.) R. Br. Rare on shale cliffs and slopes in Allegany and Washington Counties.

- *Woodsia obtusa* (Spreng.) Torrey [Blunt-lobed Cliff Fern]. Frequent as an epipetric on shaded rocks and man-made walls, and occasional on shaded rocky slopes or in sandy woods. In all counties above the Fall Line and in D.C., and Queen Anne's and Talbot Counties on the Coastal Plain.

- *Woodwardia areolata* (L.) Moore [Netted Chain Fern]. Common in large colonies in swamps and bogs in all Coastal Plain counties.

- *Woodwardia virginica* (L.) J. E. Smith [Virginia Chain Fern]. Occasional in swamps, bogs, marshes, and along pond edges in Anne Arundel, Calvert, Caroline, Charles, Dorchester, Prince George's, St. Mary's, Somerset, Wicomico, and Worcester Counties. Also disjunct in a seepage swamp in Frederick County.

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"Ironclad Beetles", the Family Zopheridae, in Maryland: Notes on the Natural History and Distribution of *Phellopsis obcordata* (Kirby)

Warren E. Steiner, Jr.

Knowledge of specific host plant-insect associations gained at one locality can often lead to new data from another. The following notes were compiled after the discovery of a single beetle specimen from Garrett County, Maryland, during a botanical foray led by Dr. Elmer and Mrs. Jean Worthley in April 1991.

The beetle was *Phellopsis obcordata* (Kirby), a species not previously reported from Maryland. It is the only eastern U.S. member of the group known as "ironclad beetles", for their hard exoskeleton and rough sculpture. The unusual body shape and dorsal surface are illustrated by Dillon and Dillon (1961). This insect is fairly common in collections from eastern Canada and the states north of Pennsylvania, but records from the southern states are rare, and little information is available on its biology or the limits of its geographic range. Also, its placement in the family Zopheridae has been recognized for a number of years (Boving and Craighead 1931, Crowson 1955, Doyen and Lawrence 1979) but, in more popular references and field guides, the group is still treated as part of the Tenebrionidae. This note will call attention to this family of odd beetles represented in Maryland's fauna and contribute some new information on the habits and distribution of *Phellopsis obcordata*. Specimens examined in this study are in the collection of the U.S. National Museum of Natural History, Smithsonian Institution.

This paper is dedicated to another "ironclad", the late Dr. Elmer G. Worthley.

Previous Work

Earlier references list only "Pa., N.H., Nfld." for the distribution of *P. obcordata* (Leng 1920). It was listed for New Jersey by Smith (1900) from "Hudson Co., Ft. Lee; on dry fungoid growths on trees: local and not common". Brimley (1938) added North Carolina, "Mountains, May-July", the only record from a southern state. For New York, Leonard (1926) gave several specific localities but no habitat data, as did other authors of earlier local lists elsewhere in northeastern states, but Hamilton (1895) noted that the beetle was "not common, in woody fungus" in Pennsylvania.

A curious record for the District of Columbia was given by Ulke (1902) for *P. obcordata* "under old bark, one specimen", with an interesting note: "The Potomac River every spring carries down quantities of flood debris from the mountain districts, containing insects which properly belong to higher elevations, for example, *Phellopsis obcordata*,...".

The first specific record of a possible host plant was given by Chagnon (1935) who reported finding *P. obcordata* near Montreal, Quebec, associated with "*Polyporus betulinus*...on dead birch" in a list of insects "living on this fungus", and other studies on the "birch bracket" fungus (now *Piptoporus betulinus* [Bull.: Fr.] Karst.) in Canada associated it with a few specimens of the beetle (Pielou 1966, Pielou and Verma 1968). None of these studies confirmed that the fungus was actually eaten.

Notes from Maine, July 1990

My earlier experiences with *Phellopsis* and other zopherid species were sporadic "lucky" finds of beetles under bark of various logs and stumps in forested habitats. When in Maine in July, 1990, before learning of the literature cited above, I found that adult *P. obcordata* were attracted to polypore fungus brackets on dead wood; locating these conspicuous conks facilitated the collection of a number of the beetles. The specimens from this study are labeled "U.S.A.: MAINE: Washington County, 8 km S. Milbridge, 22-27 July 1990; W. E. Steiner, J. M. Swearingen, A. & L. Landvoigt collectors."

The first evidence that adult *P. obcordata* actually fed upon fungal tissue was noted by me on 22 July: "In a riddled old bracket of *Piptoporus betulinus* on log of paper birch (*Betula papyrifera* Marsh), found a cluster of 5 *Phellopsis obcordata* in a cavity in the middle of the thick, leathery cortex; beetles had evidently made the cavity by feeding on the tissue & etching away from inside; their pelleted frass spilled out also. No evidence of larvae; not sure if *Phellopsis* larvae eat or live in polypore brackets. On the dead standing part of this trunk, about 2 m. high were a few smaller dry brackets--a few *Thymalus* were on these; no more *Phellopsis* but some feeding had been done similar to that on the bracket on fallen trunk."

Feeding was confirmed during the following two weeks, as captive beetles readily consumed more of this and some new pieces of *Piptoporus*, and produced more of the same pelleted droppings found in the field.

On 26 and 27 July, more *P. obcordata* were observed active during the afternoon (between 15:30 and 18:00 hrs.) feeding on a different polypore, *Fomes annosus* (Fr.) Cooke. On both fallen and standing dead balsam fir (*Abies balsamea* Mill.) with newly growing conks of the *Fomes*, 5 beetles were observed "chewing at and etching new pore layer surface" on several different conks, and another was seen resting on top of a conk. In no case had a beetle eaten deeply into the fungus. A few other specimens were found elsewhere: one under bark of a rotting fir log (with small polypores noted but no *Fomes*); one walking on steps of cabin in late afternoon; one after dark, under a board leaning up on a live fir trunk, near pile of cut wood. All sites where beetles were found were shaded by forest canopy, dominated by the fir.

Three others were taken at a different locality, labeled "U.S.A.: MAINE: Hancock County, 6 km N. Aurora near Great Pond, 25 July 1990"; same collectors as above. In mixed forest during midday, two were under dry flaps of bark on two dead standing *Betula papyrifera* Marsh.; each trunk bore conks of *Fomes fomentarius* (L.: Fr.) Kickx. No conks of *Piptoporus* were on these, but were seen on similar trunks nearby. The third *P. obcordata* was taken under bark of a cut, seasoned log of large-toothed aspen (*Populus grandidentata* Michx.). Rain during that morning likely kept beetles in hiding at this site. No evidence of adult or larval feeding by *P. obcordata* on fungi was noted at this locality.

Captive adults were kept for several days with pieces of the *F. fomentarius* brackets; beetles were apparently unable to feed on these hard sporocarps, but were seen chewing at some edges, and caused some etching of rotten wood. An intensive study (Matthewman and Pielou 1971) in Quebec did not find *P. obcordata* associated with this fungus.

The beetles typically "play dead" when disturbed. With appendages folded tightly against the body they drop to the ground, looking like a piece of dry bark. Like other Zopheridae they are flightless, and their movements are slow and cryptic.

Maryland Records

The common association in Maine of *P. obcordata* with polypore fungi on dead birches led directly to finding the species in western Maryland. On rocky, shaded slopes dominated by eastern hemlock (*Tsuga canadensis* [L.] Carr), I came upon a fallen trunk of *Betula lenta* L. about 12 cm. in diameter, with several overwintered conks of *Piptoporus betulinus* on the sides, looked for the beetle, and found it! One specimen, seen hiding at the base of a conk, was taken. Fairly "new" and not yet damaged by any insects, the conks had grown on this birch after it had fallen, probably during the previous summer.

I then went "collecting" through the holdings of U.S.N.M., and found one other Maryland specimen of *P. obcordata,* taken probably 100 years ago, not far from the recent occurrence. Label data on these two specimens are: "Oakland Md 11-7; Coll. Hubbard & Schwarz" and "MARYLAND: Garrett Co., 7 mi. N. Oakland (Swallow Falls), 27 April 1991; on *Piptoporus* on fallen *Betula lenta*; W. E. Steiner, S. F. Rudy, J. M. Swearingen, J. M. Hill Colls."

Other New Records from Southern States

The distribution of *P. obcordata* has never been fully studied. The following records will help delineate the southern limits of its range, where the beetle is apparently much less abundant.

North Carolina. One specimen, labeled "NORTH CAROLINA: Avery County, 4 mi E Linville, 14 June 1971, Gary F. Hevel & Susan Hevel". Two specimens, "Highlands, NC, 4-VIII 1930, J. Karlovic". Twelve specimens, "Mt. Mitchell, N.C., 6500 ft, VI-20-26 1937, E. Shoemaker". One specimen, "Smoky Mts., N.C., X-14-1971, Mt. Kephart, 6150 feet, T. J. Spilman".

Tennessee. One specimen, "Tusculum 1945, Greenville Tenn., Mike Wright".

Virginia. One specimen, "Jone's Cr., Lee Co. Va., Coll. Hubbard & Schwarz". Two specimens, labeled only "Va.".

West Virginia. One specimen, "WEST VIRGINIA, Pendleton County, 9 km SSE Cherry Grove, Panther Knob, 1365 m., 28 July 1986, J. M. Hill, W. E. Steiner, et al." (in notes and memory, this was found under bark on a broken end of a fallen rotting trunk of *Quercus velutina* Lam. in mixed forest). Two specimens, "W. Sulphur, W. Va., July 11-19, 1911, W. Robinson".

General Distribution

Phellopsis obcordata appears to have a boreal forest distribution, with a typical southern extension in the higher elevations in the Appalachians. Several other species have been named from northwestern North America, but their validity is uncertain and the taxonomy is currently under study. The genus is holarctic, with 3 additional species recorded from Eurasia and Japan (Gebien 1937).

Larval Habits

I have been unable to find any records of *P. obcordata* larvae feeding on or living in polypore conks, except for that of Peterson (1951): "Larvae live in shelf fungi in dense woodland." Specimen data and information from other collectors indicate that larvae live in dead wood; larvae of a Russian species are wood-boring (Keleinikova and Mamaev 1971). Of North American zopherids, Lawrence (1991) said that adults "have been recorded from fruiting bodies of various fungi, but all known larvae appear to feed under bark or in dead, rotten wood, especially that which has been attacked by white rot (delignifying) fungi." He also mentioned, however, larvae of two Australian genera that "feed in the soft fruiting bodies of *Pleurotus* or *Piptoporus*."

A few available records on preserved *Phellopsis* larvae offer some information: "In moist punky yellow pine" (Klamath Falls, Oregon, 19 July 1927); "In white fir" (Satsop, Washington, Nov. 20, 1903); "Host: *Abies* sp." (Beauty Creek, Kootenai Co., Idaho, 6 June 1976).

Remarks and Questions

Phellopsis obcordata is a species of climax and old-growth boreal forests, where naturally decaying wood is abundant. Neither adults or larvae appear to be very host-specific. Adult beetles seem to be opportunistic feeders on those species of polypore sporocarps with tissues soft enough to be eaten. They have been found under bark of rotting wood of both conifers and broad-leaf trees. In several of these cases no fungal fruiting structures were associated, suggesting that these are not essential food sources for the beetle. The few records of identified woods as larval habitat are so far limited to conifers, but this may simply be because they are the dominant trees in the regions where the beetles occur. Occasional larval feeding in sporocarps could happen when a larva enters the fungal mass from the wood on which it grows. Presence of the many other beetle species that break down fungus conks would probably be strong competition for *Phellopsis* larvae.

Dispersal of this flightless beetle would be most interesting to study, as would other aspects of its life cycle. In what stage(s) do they overwinter? What is their longevity? Are they attracted to certain species of dead woods, or to the specific fungi in them? How do they get to and find new breeding sites? A "symbiosis" of botanical and entomological knowledge will ultimately provide the answers.

Acknowledgments

Elmer G. Worthley confirmed identifications of fungi and host trees, and provided literature and general information on the Polyporaceae essential to this work and future studies. Discussions on the systematics and habits of Zopheridae with John T. Doyen, Michael A. Ivie, John F. Lawrence, and C. A. Triplehorn have been of great value. I also thank Arnold and Lois Landvoigt for the invitation to "Sea Cairn" in Maine, and the others who contributed help in travels and collecting. The draft of this paper was much improved with critical reviews by Paul J. Spangler and Richard E. White.

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Seed Dispersal By Ants (Hymenoptera: Formicidae) In The Eastern United States

Jil M. Swearingen

Introduction

More than 3,000 species of flowering plants in over 60 families have been found to have ant-dispersed seeds (Handel and Beattie 1990). Myrmecochory (Greek: mrymeco= ant; khorein= to spread) was first described by Sernander (1906), who published a monograph listing over 450 species of plants in northwestern Europe thought to have seeds with ant-attracting structures. This method of seed dispersal has been documented from every continent except Antarctica- from the moist, temperate forests of eastern North America to the arid scrub regions of Australia and Africa, which contain the majority of known myrmecochorous plants. This paper provides a literature review and summary of studies and observations on ant-mediated seed dispersal in the eastern United States, primarily from North Carolina to New York State.

Since its discovery and early documentation, myrmecochory has been studied by many researchers in an attempt to understand its ecological implications. Myrmecochory is believed to be a mutually beneficial relationship between some ant and plant species. In contrast to harvester ants (e.g. *Pogonomyrmex* spp.), which eat the living portions of seeds they collect, seed-dispersing ants typically do not consume the seeds. Instead, they feed on lipid-rich food bodies, called elaiosomes, that are attached to the seed coat. Oleic acid and 1,2-diolein, a fatty acid and a diglyceride, respectively, are believed to be the primary ant-attractants in the elaiosomes (Marshall et al. 1979, Brew et al. 1989).

Elaiosomes vary greatly in size and morphology, as exemplified by the seeds of four myrmecochorous species depicted in Figure 1. After the diaspore (seed plus elaiosome) is carried to a nest, the workers remove the elaiosome and allow larvae to feed upon it. The seed, with its live embryo, is set aside. In carrying the diaspores to their nest, the ant colony gains a valuable food source. In turn, the plant benefits by having its seeds buried in or around the typically fertile and well aerated soil produced by the ants. There, the seeds are safe from fire and seed predators, and have been moved away from the parent plant. Dispersal is maximized by some plants, for example bloodroot (*Sanguinaria canadensis*), and most violets (*Viola* spp.) through an initial ballistic propulsion that is often followed by ant dispersal (Beattie and Lyons 1975, Berg 1966).

Discussion

Ecology and Evolution of Myrmecochory

Myrmecochory has been shown to be an important means of seed dispersal for many herbaceous plant species in the deciduous forests of the northeastern United States. In a study of a beech-maple forest in New York, Handel et al. (1981) found that 33-46% of total herbaceous species and over 50% of total stems in sample quadrats were ant-dispersed. Similarly, Beattie

and Culver (1981) determined that 30% of the herbaceous flora in ten random forest sites in West Virginia was ant-dispersed. They also suggest that the amount of ant activity is correlated with overall herbaceous species richness and may indicate the expected number of ant-dispersed plant species for a given site.

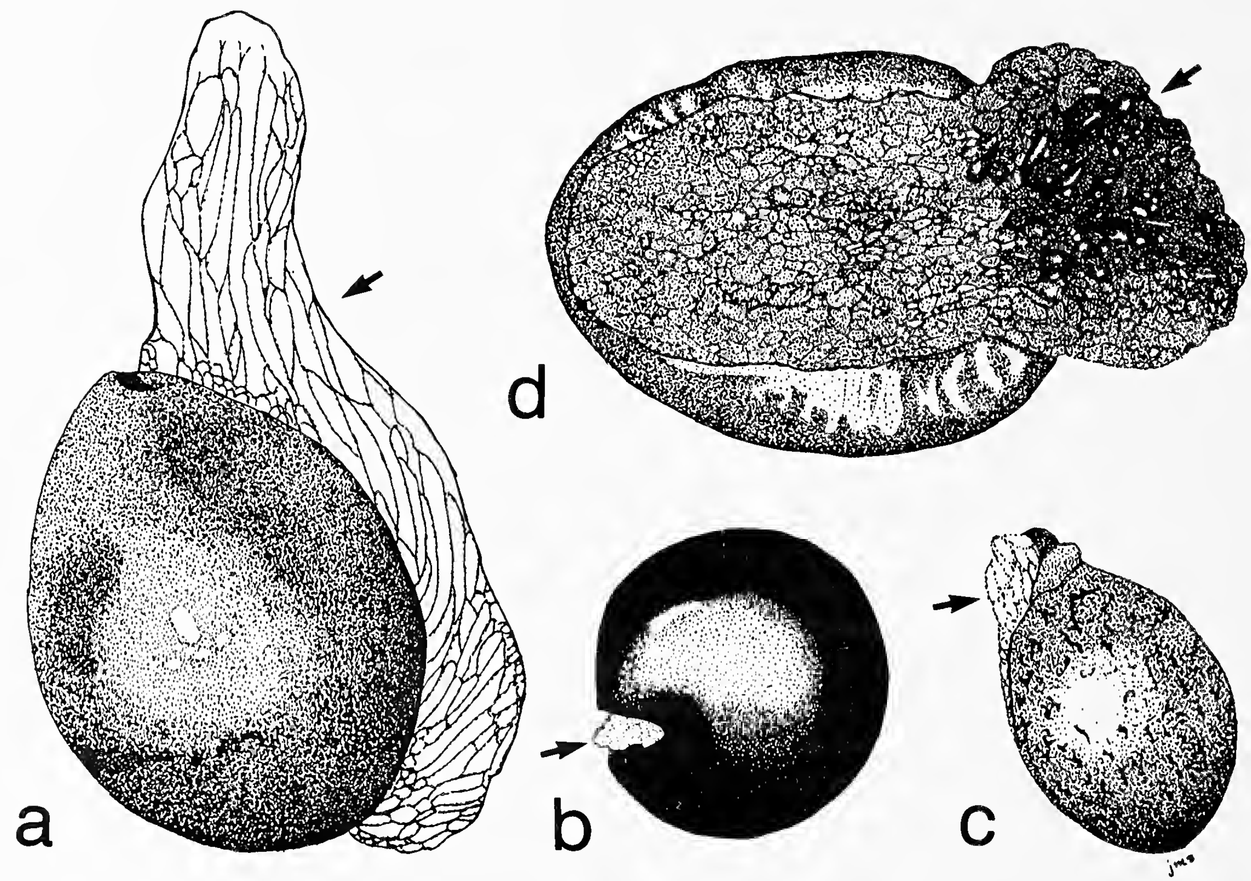

Figure 1. Elaiosomes (arrows) and seeds of four ant-dispersed plant species common to eastern deciduous forests of the United States: a. *Sanguinaria canadensis*, b. *Luzula acuminata*, c. *Viola sororia*, d. *Asarum canadense* (seed and elaiosome of twinleaf, *Jeffersonia diphylla*, is shown in illustration appearing on front cover of this issue). *Luzula* seed= 3 mm, all seeds drawn to scale.

In an attempt to identify salient features of some common ant-dispersed plants, Beattie et al. (1979) studied dispersal related characteristics of *Hepatica*, *Sanguinaria* and *Viola,* three genera of spring-flowering herbs. They looked at factors such as diaspore size, distance from parent plant that diaspores are dispersed by plant mechanisms, resultant groupings of diaspores on the forest floor, and accessibility, or presentation, of seed pods and diaspores to dispersal agents. Ants showed little specialization for particular plant species, except that larger ants were generally found to take larger diaspores.

In a study by Swearingen (1988), seed preference of two common seed-dispersing ants was examined in relation to foraging theory. Diaspores of ant-dispersed herbaceous plant species found in rich, mesic forest communities were offered to the ants *Lasius alienus* and *Aphaenogaster rudis*. Four species of myrmecochores were examined: bloodroot (*Sanguinaria canadensis*), twinleaf (*Jeffersonia diphylla*), wild ginger (*Asarum canadense*), and wooly blue violet (*Viola sororia*). These species have morphologically diverse seeds and elaiosomes. Because the elaiosome, not the seed, is the actual food being sought, it was hypothesized that ants would prefer diaspores with either the largest elaiosomes or the largest elaiosome-to-diaspore masses. Dry weight elaiosome-to-diaspore (e/d) mass was used to compare the relative amount of food each diaspore had to offer the ants. Diaspore selection was expected to vary according to the abilities of the *Lasius* and *Aphaenogaster* workers to transport the four diaspore types back to their nests.

Results of laboratory experiments with *L. alienus*, the smaller of the two ants, indicated that it preferred seeds of violet, with the smallest diaspores, over the other three species. However, when violet seeds were unavailable, *Lasius* workers strongly preferred wild ginger, which has the highest e/d ratio of the four plant species. Diaspores of violet have the second highest elaiosome-to-diaspore ratio and were easily carried by individual workers even when placed far (e.g., 180 cm and 360 cm) from the nest. As many as five of these diaspores could be brought to the nest in the time that it took to retrieve one of the others. Transport of the larger diaspores (i.e., ginger, bloodroot, and twinleaf) required the laborious and often ineffective coordination of up to four workers per seed. The preference of *Lasius* for the two diaspore types with the highest e/d ratios, suggests that the elaiosome-to-diaspore value may underlie its seed preferences.

In a similar field study with *A. rudis*, seeds of the same four species were presented and replaced soon after removal by an ant. While all four species were taken by *A. rudis*, twinleaf, with the largest diaspore and elaiosome of the four species, but the lowest e/d ratio, was strongly preferred. All four diaspore types were easily carried by individual *Aphaenogaster* workers. For *Aphaenogaster*, diaspore and elaiosome size appear to be more important in influencing seed selection than the elaiosome-to-diaspore value, at least within the size range of diaspores that were offered. However, the influence of pheromones released by elaiosomes or other structures on ant behavior may be found to play an important role in seed selection by these and other seed-dispersing ant species.

A number of hypotheses have been investigated to explain the ecological and evolutionary significance of myrmecochory. Studies relevant to the eastern United States include adaptation of some shade-tolerant forest herbs to overcome nutrient scarcity (Beattie and Culver 1981), plant avoidance of seed predators (Heithaus 1981), and interspecific competition among plants for germination sites (Handel 1978a). Which of these factors is most important appears to depend on site conditions and the existing species complex.

Beattie and Culver (1981) conducted a large-scale study of shade-tolerant, herbaceous plant species at ten hardwood forest sites in West Virginia. Shade-adapted forest herbs may have special nutrient needs because nutrients such as nitrogen and phosphorous are bound up in the living forest biomass. Beatie and Culver found that plant species depended upon ants for

dispersal of their seeds, and their distributions in the forest were found to be correlated with nests of seed-dispersing ant species. It was found that ant nests were richer in nutrients than was the surrounding forest soil, thus ant nests would provide favorable sites for seed germination, seedling emergence and plant establishment.

Heithaus (1981) found that predation by small mammals causes significant seed mortality among many herbaceous plant species in mesic deciduous forests of the eastern United States. He found that 24 and 47% of the seed crops of wild ginger (*Asarum canadense*) and twinleaf (*Jeffersonia diphylla*), respectively, were destroyed by the white-footed mouse, *Peromyscus leucopus*, and other seed predators. Seed predation more than doubled when seed-dispersing ants were excluded from plots. In addition, the author found that removal of elaiosomes and subsequent burial of the seeds by seed-dispersing ants appeared to reduce the ability of small mammals to locate these seeds.

Reduced competition by plants for germination sites, through ant-mediated seed dispersal, was suggested to be an important factor in the life history of the long-stalked sedge, *Carex pedunculata* (Handel 1978a). This sedge is found with two other species of *Carex* at some mesic forest sites in West Virginia. Unlike the neighboring sedge species, it has ant-dispersed seeds that germinate readily and do not require an overwintering period. In laboratory experiments, *C. pedunculata* was found to grow poorly in the immediate vicinity of the other two species. However, when grown in monoculture it showed vigorous growth, and greater production of rosettes, flowering culms, and seeds. Ant dispersal of its seeds appears to be a way for *C. pedunculata* to reduce competition with sympatric sedge species by distributing its seeds over a greater area of the forest floor than might otherwise be possible.

The Ants

Research on myrmecochory in the United States has focused on the temperate deciduous forests east of the Mississippi River. Only twenty-nine species and subspecies of seed-dispersing ants have been documented for this region (Table 1), compared to 1500 species in Australia (Berg, 1975) and a similar number in Africa. Much valuable information has come from these studies, but further investigations are needed to identify additional myrmecochorous associations and to understand their ecological role in other ecosystems in the eastern U.S., and nationwide. Ant-mediated seed dispersal may be an important and overlooked factor in ecosystem restoration and conservation projects.

More than one hundred species of ants are known or expected to occur in the Coastal Plain of Delaware, Maryland and Virginia, according to Lynch (1987). Twenty species of seed-dispersing ants that occur in Virginia's Piedmont and the mountain region of eastern West Virginia, are included on Lynch's list. While many myrmecochorous plant species occur in the Chesapeake Bay region, no records of seed-dispersal by ants have been published for this entire geographic region.

The barrier islands off the Atlantic Coast of the United States probably contain a unique assemblage of myrmecochorous associations, but have not been studied to date. On September

12, 1986, at Ocracoke Island, North Carolina, I observed workers of *Pheidole morrisi* transporting seeds of *Croton punctatus* into a nearby nest. *Croton* occurs in sandy, exposed areas of back dunes and has three-seeded fruits that split and fall from the plants when mature. I later discovered this to be the first report of seed dispersal for *Croton* in the eastern United States and the first record of myrmecochory on the barrier islands.

Table 1. Known seed-dispersing ant species from Massachusetts (MA), North Carolina (NC), Virginia (VA), and West Virginia (WV), and possible seed dispersers in the Chesapeake Bay Region (CB). Numbers refer to references identified in the literature cited section of this paper. Species recorded from Virginia are based on personal observations of L.R. Rockwood, unless otherwise noted.

Ant Species	State(s)	Reference
Acanthomyops interjectus	MD	Pers. obs.
Aphaenogaster rudis	CB,NY,VA,WV	2,3,13,15,18,20,21,25
Aphaenogaster tennesseensis	CB,NY,VA,WV	2,15,21
Camponotus ferrugineus	CB,VA	21
Camponotus pennsylvanicus	CB,VA	21
Camponotus subbarbatus	CB,VA	21
Crematogaster cerasi	CB,WV	2,21
Crematogaster lineolata	CB,VA	21
Formica difficilis	CB,WV	2,21
Formica fusca	NY,WV	4,15
Formica integra	CB,WV	9,21
Formica neogagates	MA	12,21
Formica p. pallidefulva	CB	21
Formica p. nitidiventris	CB,WV	2,21
Formica subsericea	CB,VA,WV	3,18,21
Lasius alienus	CB,VA,WV	2,3,9,21,25
Lasius "americanus"	MA	12
Leptothorax curvispinosus	CB,VA,WV	9,21
Leptothorax longispinosus	CB,VA,WV	9,21
Myrmica emeryana	CB,VA,MA	12,21
Myrmica punctiventris	CB,VA,WV	2,3,18,21
Myrmica spatulata	WV	4
Paratrechina parvula	CB,VA,WV	2,21
Paratrechina sp.	VA	
Pheidole morrisi	CB,NC	21, Pers. obs.
Stenamma impar	CB,VA	21
Stenamma schmitti	CB,WV	9,21
Tapinoma sessile	CB,VA,WV	2,4,9,21
Tetramorium caespitum	CB,VA	21

I have observed other instances of possible myrmecochorous associations among several exotic and cultivated plant species. During March 1991, I over-turned a disk of oak used as a stepping stone in a flower garden belonging to Dr. and Mrs. Elmer Worthley in Finksburg, Maryland. A large cache of seeds from a nearby blue dogbane plant (*Amsonia tabernaemontana*) were found under the disc and appeared to be tended by a heavy-bodied, yellow ant, later identified as *Acanthomyops interjectus*. There were no visible signs of elaiosomes showing on

the seeds, although a drawing in a botanical reference depicted *Amsonia* as having these structures. While this suggests a myrmecochorous association, confirmation will need to be made during late summer when fresh seeds are available.

Another instance of seed dispersal by ants was made in August 1990 when I set out freshly collected seeds of the noxious exotic weed *Polygonum perfoliatum* (perfoliate tearthumb) in the vicinity of nests of *Lasius alienus* and *Aphaenogaster* sp. at my home in Rockville, Maryland. I had noticed what appeared to be elaiosomal structures on these seeds and wondered if they would be attractive to ants. Five seeds were placed approximately three feet from a stone wall containing nests of these ants. Within ten minutes, the ants had carried all seeds into crevices in the wall. While birds are believed to be the major dispersers of the seeds of the perfoliate tearthumb, ants may play an important role in establishing this plant by dispersing and planting its seeds in better germination sites.

The Plants

In the eastern United States nearly three dozen plant species in thirteen families have documented myrmecochorous associations (Table 2). Further research will likely add many additional species and families to this list. Most of these plants flower and produce seed in the Spring (March through June in the middle Atlantic states).

Table 2. Plant species in the northeastern United States known to have ant-dispersed seeds. Numbers refer to references listed in the literature cited section of this paper.

Plant Family	Plant Species	State(s)	Source
Apocynaceae	*Amsonia tabernaemontana*	MD	Pers. obs
Aristolochiaceae	*Asarum canadense*	VA,WV	2,18,19,20
Berberidaceae	*Jeffersonia diphylla*	VA,WV	2,18,20,25
Cyperaceae	*Carex communis*	NY	15
	C. jamesii	WV	2
	C. laxiculmis	WV	2
	C. pedunculata	WV,NY	13,14
	C. umbellata	NY	15
Euphorbiaceae	*Croton punctatus*	NC	Pers. obs.
Fumariaceae	*Corydalis flavula*	WV	2
	Dicentra canadensis	VA	Pers. obs.
	Dicentra cucullaria	VA	6
Juncaceae	*Luzula acuminata*	NY	15
	L. campestris	NY	15
	L. echinata	WV	2

Table 2 (Continued).

Plant Family	Plant Species	State(s)	Source
Liliaceae	*Trillium erectum*	WV	2
	T. grandiflorum	MA,NY,WV	2,11,20
	Uvularia perfoliata	WV	2
Papaveraceae	*Sanguinaria canadensis*	MA,VA,WV	3,11,12,18, 20,23,25
Polygonaceae	*Polygonum perfoliatum*	MD	Pers. obs.
Portulacaceae	*Claytonia virginiana*	NY,SC,VA	14,15,18,25
Ranunculaceae	*Anemone quinquefolia*	WV	2
	Hepatica acutiloba	NY,WV	3
Violaceae	*Viola blanda*	NY,VA,WV	1,3,4,9
	V. canadensis	NY	4,9
	V. eriocarpon	NY	4,9
	V. pedata	WV	1,3
	V. pensylvanica	WV	1,3
	V. rostrata	WV	1,3
	V. sororia	VA,WV	3,25
	V. striata	NY	4,9
	V. triloba	WV	3,4

Summary

Knowledge of myrmecochory in the eastern United States is based on studies confined primarily to the deciduous forests of the piedmont and mountain regions of Virginia, West Virginia and New York. Myrmecochorous associations in the Atlantic Coastal Plain, barrier islands, and many other ecosystems in the eastern United States are virtually unknown. Seed dispersal by ants has been shown to play an important, possibly crucial, role in the ecology of forest herbs. Seed-dispersing ants may also play an important role in conservation and restoration projects.

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Arnold W. Norden, Editor

Mailing Date: 20 November 1992

Cover Illustration: Ancient stumps of bald cypress trees exposed at Pinehurst near Bodkins Creek in northeastern Anne Arundel County. These stumps were about 35,000 years old. This photograph was made by John Calder about 1930, and the fossils have since been lost to erosion. Original photograph from the files of the Natural History Society of Maryland.

The Roop Mine, Revisited

Fred J. Parker

The A. A. Roop Mine operated for a short period during the late nineteenth century. It was located about two miles southwest of New Windsor in Carroll County, Maryland. The main operation consisted of an open pit quarry and at least one vertical shaft penetrating to a depth of about sixty feet. Several smaller pits and exploratory trenches were also dug. Mining began in the mid 1870's and several hundred tons of copper and possibly oxidized zinc ores were removed and shipped for processing. The operation proved unprofitable, however, and mining ceased in the early 1880's.

The ore mineralogy of the deposit was simple and similar to other copper-zinc deposits in the Wakefield Marble (Heyl and Pearre 1965). Primary ores were the copper-iron sulfides chalcopyrite and bornite, and the copper sulfide chalcocite. Secondary copper carbonates were intimately admixed with the sulfides. Stains and encrustations of green malachite were common, as they are throughout the Wakefield Marble. However, deep blue azurite as stains and small crystals made the Roop Mine unique among Maryland's copper deposits. Large, choice specimens collected over fifty years ago are still preserved at the Natural History Society of Maryland. Traces of other minerals were also reported, including hydrozincite, tenorite, galena, sphalerite, covellite and smithsonite.

My interest in this locality was sparked by an article discussing the mine that was published in 1946 by Herbert Bangs. His description, based on a site visit made in October of 1945, is excerpted below.

> "The farm is situated in a narrow limestone valley which is divided lengthwise by a low, broken ridge. An abandoned limestone quarry is located in the side of this ridge, a few hundred feet south of the huge stone livestock barn. The floor of the quarry is overgrown with young trees and swamp grass, but at the foot of the south face a water filled shaft marks the deposit. Several feet of mineralized limestone are exposed; the copper sulfides, chalcocite and bornite were found, filling seams and cracks in the rock, accompanied by a wide belt of snowy white stone very beautifully impregnated with the copper carbonates, malachite and azurite. We collected several specimens here, including a small group of minute radiating azurite crystals. We next visited the No. 5 Pit, which is 1600 feet on an azimuth of 170° from No. 1. The sides of this little quarry are overgrown with grass and bushes, but the few rocks still exposed contain traces of a metallic mineral, possibly sphalerite. At Pit No. 2 we found no indications of metallic minerals. We did not visit Pit No. 7, the only other working still accessible, but copper ores have been reported there by Frazer."

When I learned that a proposed quarry would probably obliterate the A. A. Roop Mine I decided to visit the site and make a photographic record for historical purposes. Using a 1875 map that was reproduced by Bangs (1946), locating the site was easy and, after securing permission from the present property owner, I spent several hours there on a dismal rainy afternoon. Despite the passage of nearly fifty years I found it much as it was when visited by

Bangs, and the water-filled shaft along the base of the open cut was noted, along with several shallow prospect trenches. Although the exposed quarry face had weathered severely, copper sulfide veins were easily located. Several small stains of azurite were collected, as were small vugs of drusy calcite crystals with botroydal malachite.

As I walked away from the remains of the Roop Mine, I realized that its days were numbered by regional industrial and residential development. This same fate has already claimed the Dolly Hyde and Unionville Zinc Mines. I was pleased to have had the opportunity to collect some ore specimens and make a photographic record of the site. It is ironic that the last days of the Roop Mine may be its best. As future quarrying operations intrude on the original workings, the ore veins may again be well exposed to interested persons one last time before they pass into history as a footnote to Maryland's copper mining industry.

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A Specimen of the Eastern Spiny Soft-shelled Turtle, *Apalone spinifer spinifer* (LeSueur) from St. Mary's County, Maryland

Kyle Rambo

On 17 June 1991, Captain F.D. Schwikert reported a specimen of the eastern spiny soft-shelled turtle, *Apalone spinifer spinifer* (LeSueur) to the author. Capt. Schwikert picked up a large, apparently adult female specimen which was crossing a paved road between two freshwater ponds on the Patuxent River Naval Air Station in southern St. Mary's County, Maryland. While the specimen was released before it could be examined by the author, it was well described by Schwikert.

Captain Schwikert is a U.S. Naval officer and amateur naturalist stationed at Patuxent River. He has had considerable experience with *A. spinifer* while at other duty stations in the midwest. He described in detail an individual of this species about twelve inches in length, which he returned alive to Station Pond #3. The turtle had the distinctive soft leathery shell with spiny protuberances near the forward edge of the carapace. It was a light grey-brown in color with dark blotches on the carapace and legs. Subsequent trapping produced painted turtles (*Chrysemys picta*), redbelly turtles (*Chrysemys rubriventris*), and eastern mud turtles (*Kinosternon subrubrum*), but failed to produce additional adults or young of *A. s. spinifer*. Thus, there is no evidence to suggest that a breeding population of this species exists at Patuxent River.

Mansueti and Wallace (1960) summarized the literature and documented occurrences of *A. s. spinifer* in Maryland. They discussed a specimen, believed to be an introduction, which had been captured in tidewater Anne Arundel County in 1953. Dukehart (1884) described an attempted introduction of this species into the Potomac River at Cumberland in 1883. That introduced population is generally believed to have died out. Roddy (1928) suggested it may occur in the lower Susquehanna, but McCauley (1945) refuted that suggestion by pointing out that no specimens exist to support it. Carr (1952) and Webb (1962) indicated its likely historic occurrence in the Ohio River drainage of extreme western Maryland. Ortmann (1909) however, commented on its probable extermination from the Youghiogheny River due to pollution. Until the collection of seven hatchlings from the Youghiogheny in 1970 (Wemple 1971), there was no evidence of a naturally occurring breeding population in Maryland. The resident *A. spinifer* in the Youghiogheny River were recently listed as "Species in Need of Conservation" by the Maryland Department of Natural Resources, and specimens can not be collected without a special permit.

While the Naval Air Station is located only a few miles from the Potomac River, the specimen observed is almost certainly an introduction, perhaps as the result of a pet release. The occurrence of such introductions on military installations may be a common phenomenon due to the high turnover of military personnel, arriving and departing from duty stations across the country and around the world.

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The Ichthyofauna of Goose Creek, Potomac Drainage, Virginia

Robert L. Vadas, Jr.

Abstract

Fish collections (seining, trapping, fly-fishing, and electrofishing) from Goose Creek were used to evaluate species diversity, composition, and relative abundance over a 35-year period. Forage fish data indicated that the spotfin shiner (*Cyprinella spiloptera*) was consistently dominant, whereas the subdominant species (mostly minnows) were usually the same among samples. Adult redbreast sunfish (*Lepomis auritus*) was the dominant game fish, and several other centrachids were also important. Given the high species richness and diversity of samples, as well as the consistency in species composition and relative abundance during the evaluation period, the fish fauna showed evidence of persistence and stability, despite a variable flow regimen. These data were likely indicative of the relatively pristine water quality and habitat structure of Goose Creek.

Introduction

Ichthyofaunal surveys have been used by stream ecologists in the last decade to examine the persistence (the same species always being present) and stability (the relative abundance of species always being the same) of fish assemblages across years (Bain and Boltz 1989; Grossman et al. 1982, 1990; Matthews 1990; Moyle et al. 1982; Zalewski and Naiman 1985). Fish assemblages have also being assessed, both within and between watersheds, to determine if species diversity, composition, relative abundance, and trophic structure are affected by pollution and changes in habitat structure (Fausch et al. 1990, Schlosser 1987). Thus, fish surveys are important for determining spatiotemporal patterns in lotic ecosystems.

The objective of this study is to evaluate the composition, relative abundance, and diversity of fish species in Goose Creek, Virginia, over time and space. As this relatively undisturbed, warm water stream is part of the state's Scenic River System (Anonymous 1985), the information presented here may provide a database for the comparison of ichthyofaunal patterns in unaltered Potomac River tributaries.

Study Area

The Goose Creek watershed (860 square km) originates in the Blue Ridge Mountains (Faquier County) and flows into the Potomac River below Leesburg (Loudoun County), Virginia (Figure 1). At its mouth the stream is sixth order in size, based on the Strahler/1:24,000 method (Hughes and Omernik 1983, MacDonald 1983). Stream gradient varies from 1.2 to 25 m/km from mouth to headwater. Two newly built impoundments occupy the lower section, one on the stream (Goose Creek Reservoir) and the other on a tributary. Although poor farming practices in the 1940's caused heavy siltation in the watershed (Riley 1990), Goose Creek is now considered to have good water quality. The drainage supports a diversity of riparian-wildlife species, and flows mostly through forest and agricultural land in its upper reaches and forest and

urban areas lower down (Anonymous 1985, Palmer 1990, RLV personal observation). Goose Creek also supports a variety of recreational activities, including canoeing and kayaking during high flows, fishing, swimming, and tubing (Anonymous 1985, RLV personal observation). The underlying bedrock of the watershed is biotite granitic gneiss (Margaret E. Palmer, personal communication).

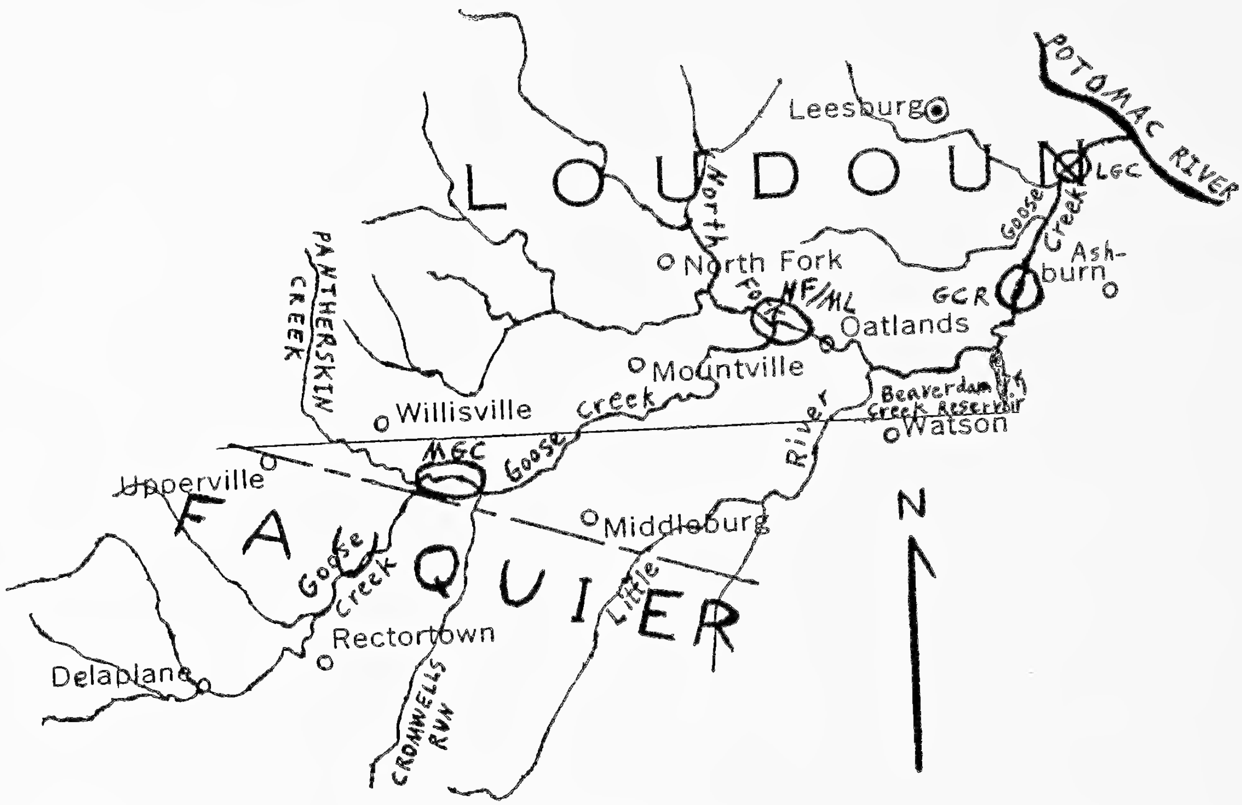

Figure 1. Map (1:200,000 scale) of Goose Creek watershed, located in Faquier and Loudoun Counties of Virginia, Potomac River basin. Study sites are circled, and include middle Goose Creek (MGC), North Fork and middle-lower Goose Creek (NF/ML), Goose Creek Reservoir (GCR), and lower Goose Creek (LGC). Reference townships and other landmarks are indicated. The map was modified from a U.S. Geological Survey map of Virginia hydrologic units.

Middle Goose Creek (MGC) is a fourth-order, 4 km stretch located between Middleburg and Upperville (Figure 1). Summer stream width ranges from 3 to 16 m, and the deepest areas are 1.2 m (Palmer 1990, RLV unpublished data). The gradient (1.3 m/km) and sinuosity (1.5) are moderately low, the bottom is sand-gravel (rocks are mostly restricted to the few riffle areas), and the erosional-depositional sequence is irregular. The stream channel has not been directly altered by humans, as the thalweg (the deep, fast chute) alternates stream banks in regular fashion and mature deciduous trees line the banks in several areas. The banks are steep and moderately

eroded, with little instream woody debris in shallow areas, few aquatic macrophytes, and restricted accumulation of organic matter (periphyton and leaves were only abundant during August-September and September-October, respectively). This probably reflects the severity of cold-weather floods, which regularly move large (50 cm diameter) logs downstream and can greatly modify habitat (cf. Bryant et al. 1989, Ross 1959, RLV personal observation 1986-1990). The flow regimen is considered to be variable, as drought intermittence occurred three times in the last six years (1985, 1986, and 1991) (Palmer 1990, Prugh et al. 1989, RLV personal observation).

Surface and bottom (frazil) ice are common during winter, the former sometimes completely covering depositional areas. The macro and micro-invertebrate fauna is diverse (Palmer 1990; Vadas 1988, 1990), and large invertebrates collected during 1986-1991 fish sampling included crayfish, snails, nymphs of mayflies, stoneflies, and odonates, larvae of tipulids and fishfly megalopterans, and semi-aquatic taxa (water boatmen and heteropterans). Aquatic and semi-aquatic herptiles and mammals, as well as piscivorous birds were regularly seen.

Materials and Methods

Middle Goose Creek Fish Samples

I sampled MGC during 1986-1991, by trapping, seining, fly-fishing, backpack electroshocking, and electroseining. This variety of techniques compromised the consistency of fish collecting but allowed a broader range of size classes and species to be sampled, as well as comparisons among techniques to be made.

Trapping was conducted from July to September in 1986, May to October in 1987, and July to October in 1988, with best success in shallow areas and during warm weather. The technique employed was similar to that of Mendelson (1975) and Coon (1982). Mason-jar traps were baited with white bread and dog food pellets and stacked on metal stakes distributed throughout the mesohabitat(s) being sampled. The traps were monitored every 1-3 hours over two days, although nocturnal monitoring was minimized because of low catch rates. All fish were preserved in 10% formalin and transferred to 70% ethanol before being identified.

During non-winter months (April to November) of 1986-1987, eight qualitative, half to one-day seining collections were made. Fish species were classified as abundant (two points), uncommon (one point), or absent (zero points) at one or both sets of stations (A and B/C) (cf. Vadas 1988, 1991). A few mesohabitats from each station were sampled during each trip, to sample various depths and velocities. There were 13 total samples, the minnow seine had 5 mm mesh, and fish were released after sampling. The seine hauls of 1988 were similar, except fish were counted, all mesohabitat within stations was sampled, each sample required one to 3-1/2 days of work and seine mesh was 7 mm (Vadas 1991). Cold-weather collections required vigorous stirring of bottom leaves to collect cyprinids effectively.

Water-column game fishes were more effectively sampled by angling with small trout flies. Five collections (one to 1-1/2 days each) were made during summer/fall (July to October) months of 1987-1988. Both sets of stations were sampled, especially in deeper areas with woody

debris (which were more productive); 40 fish (20-76 range) were caught in all but one trip. All fish were identified then simultaneously released after an area was sampled.

During 13-14 October 1990, fish collecting was undertaken throughout both sets of stations during a flood. During peak discharge, only floodplain sampling with an AC-powered Coffelt backpack electroshocker was possible. The next 1-1/2 days were devoted to seine hauls and kick samples as during 1988, although only shoreline areas in deeper mesohabitats were accessible. Fish were identified and most were released.

During 27 August 1991, electroseining was undertaken in two drought-isolated pools of station C (100 m total length) using one-pass depletions and the equipment of Angermeier et al. (1991). Both game and forage fishes were tabulated (Poff et al. 1992).

All species names conform to Robins et al. (1991).

Other Fish Samples

Presence-absence ichthyofaunal data were collected during 1956, 1964, 1974, and 1980-1983 by the Virginia Department of Game and Inland Fisheries (VDGIF, unpublished data) in Goose Creek, Loudoun County, with electroshockers and/or seines. Ross (1959) similarly electroseined upper and lower Goose Creek, including three of its lower tributaries, during August of 1956. VDGIF has also sampled shoreline areas of Goose Creek Reservoir with electroshockers and trap nets.

Paul L. Angermeier and colleagues (unpublished data) electroseined two 100-200 m stretches in downstream (Loudoun County) reaches of the watershed, using standard methodology (Angermeier et al. 1991). Two pools in the North Fork of Goose Creek (8-9 m stream width) were sampled 20 August 1987 near the confluence with Goose Creek (Figure 1). Riffle, run, and pool habitats in mid-lower Goose Creek (14-26 m stream width) were sampled 10 Aug. 1989, downstream from the confluence.

Angermeier and colleagues (unpublished data) also boat-shocked two downstream, sixth order sections in 1989, using a Coffelt rectifier, AC power, and one hour passes. Shorelines at the upper end of Goose Creek Reservoir were sampled on October 5. Various shoreline and midstream habitats in lower Goose Creek, just below the confluence with Tuscarora Creek, were sampled on October 6.

Statistical analyses

Varimax factor analysis (Davies 1984), percent-similarity and Simpson/Levins diversity indices (Washington 1984) were used to analyze fish-assemblage data (cf. Vadas 1991). The null hypothesis was that fish relative abundance was not consistent over time and space, i.e., that assemblage patterns were unrelated among years and sampling methods.

Results and Discussion

Long-Term Persistence of the Fish Fauna

Lotic areas of Goose Creek supported a variety of game and forage fish species, especially cyprinids and centrarchids (Table 1). During 1986-1991, 43 species in eight families were collected, all but nine game species being sampled in MGC. These numbers are similar to the 1980-1983 catches (36 species in seven families). However, species richness during these two recent periods were higher than that during 1956-1974 (only 32 species in eight families). Twenty one species in six families were collected in Goose Creek Reservoir, including four species not found in the stream itself. Of the 38 lotic species collected during 1956-1983, only two (*Clinostomus funduloides* and *Campostoma anomalum*) were not collected during 1986-1991. These species may have been missed because none of the "new" collections were taken in headwater areas (cf. Lee et al. 1980). *Notropis amoenus*, which is probably intolerant of pollution and disappearing from the Potomac River basin in general (Dietemann 1974, 1975; Dietemann and Giraldi 1973), was only collected in 1956, 1974, and four boat-shocked specimens taken in 1989 in the creek itself. *Etheostoma blennioides*, in contrast, was first collected in 1964, evidence of its successful invasion of Virginia Potomac tributaries since 1960 (Schwartz 1965).

Table 1. Presence-absence ichthyofaunal data from Goose Creek and Goose Creek Reservoir, Loudoun County, during the past 35 years. Species presence in the stream is indicated as O (old, 1956-1974), R (recent, 1980-1983), N (new, 1986-1991), or + (contemporary presence in the reservoir), whereas * designates new species not collected in MGC. Suspected pollution-sensitive species in Potomac tributaries (Dietemann, 1974, 1975; Dietemann and Giraldi 1973) are indicated as #.

Taxon	When collected
Anguillidae	
Anguilla rostrata *	O,R,N
Catostomidae	
Catostomus commersoni	O,R,N,+
Erimyzon oblongus	O,R,N,+
Hypentelium nigricans	O,R,N
Moxostoma erythrurum *	N
Centrarchidae	
Ambloplites rupestris	O,R,N
Lepomis auritus	O,R,N,+
L. cyanellus	O,R,N,+
L. gibbosus	O,R,N,+
L. gulosus *	N
L. macrochirus	O,R,N,+
L. megalotis *	R,N,+
L. microlophus	+
Micropterus dolomieu	O,R,N,+
M. salmoides	O,R,N,+

Table 1. Continued.

Taxon	When collected
Pomoxis annularis	R,N
P. nigromaculatus *	N,+
Clupeidae	
Dorosoma cepedianum	+
Cottidae	
Cottus girardi	O,N
Cyprinidae	
Campostoma anomalum	O,R
Carassius auratus	N
Clinostomus funduloides	R
Cyprinella analostana	R,N
C. spiloptera	O,R,N,+
Cyprinus carpio *	N,+
Exoglossum maxillingua #	O,R,N
Luxilis cornutus	O,R,N
Notemigonus crysoleucas #	R,N,+
Notropis amoenus #,*	O,N
N. buccatus #	O,R,N
N. hudsonius	O,R,N
N. procne	O,R,N
N. rubellus #	O,R,N
Nocomis micropogon	O,R,N,+
Pimephales notatus	O,R,N
Rhinichthys atratulus	O,R,N
R. cataractae #	O,R,N
Semotilus atromaculatus	R,N
S. corporalis	O,R,N
unidentified minnows	+
Cyprinodontidae	
Fundulus diaphanus	O,R,N
Ictaluridae	
Ameiurus natalis #	O,R,N,+
A. nebulosus *	N,+
Ictalurus punctatus *	N,+
Noturus insignis	O,R,N
Percidae	
Etheostoma blennioides	O,R,N
E. flabellare	O,R,N
E. olmstedi	O,R,N,+
Perca flavescens	+

In summary, these data suggest that the Goose Creek fish assemblage is persistent in species composition, with no obvious extirpations since the 1950's. The species richness of MGC's fish assemblage and individual fish families was high relative to other Potomac streams of similar size (Dietemann 1974, 1975; Dietemann and Giraldi 1973), and several pollution-sensitive species were abundant or at least present (Table 1). This suggests that MGC is unpolluted (Fausch et al. 1990), which is supported by water-quality data and habitat-structure observations (Anonymous 1985, Palmer 1990, RLV personal observation).

Game Fish Assemblage of MGC

Four to six game fish species (defined as centrachids, ictalurids, and *Semotilus corporalis*) were collected per fly-fishing sample, including the adults and larger juveniles of five centrarchid and one cyprinid species. The redbreast sunfish (*Lepomis auritus*) was consistently dominant, and always contributed at least half the catch (50-63%). *Lepomis cyanellus* was consistently subdominant, and comprised nearly a fifth of the catch (15-20%). Variable subdominants included *L. macrochirus* (0-22.5%), *Ambloplites rupestris* (3-20%), *Micropterus dolomieu* (0-9%), and *Semotilus corporalis* (0-3%). Hybrid lepomines (*L. cyanellus* x *L. macrochirus*) were rare (0-2%). Percent similarities for the five 1987-1988 samples were high (75-91%) and species diversity was relatively constant (2.2-3.0), which indicates temporal consistency in the game-fish assemblage.

The six species identified above were among the seven most abundant game fishes in the Potomac River and larger tributaries in past decades, with the redbreast sunfish and *Micropterus dolomieu* being especially common (Sanderson 1958, Elser 1965). The low abundance of catostomids in Elser's (1965) and my own creel sample contrast with Sanderson's (1958) electrofishing samples and my own visual surveys in MGC (personal observation 1986-1988), which suggest that *Hypentelium nigricans* is also important. Despite the sample biases, the high numbers of centrarchids that I fly-fished per unit time, observed during visual surveys, and electroseined during 1991 (see below) suggest that centrarchids were important elements of the MGC ichthyofauna (cf. Ross 1959). The redbreast sunfish is well-known for being an abundant habitat generalist in the southeastern U.S. (Shannon 1966), often being found with *Lepomis macrochirus* in Piedmont streams like Goose Creek.

Forage Fish Assemblage in MGC

Eleven forage fish species (defined as species and size classes under 100 mm standard length) in seven families were collected. Fry (below about 25 mm SL) were invulnerable to capture because of their small size and preference for shallow shorelines. Eleven species, including nine cyprinids and two lepomines, were subjected to factor analysis. This analysis generated three important factor axes, which revealed the similarity of the two trap samples (factor one) and the two semi-quantitative seine collections (factor two). The qualitative seine sample proved to be unique (factor three) (Table 2). These results stemmed from consistent differences in species' relative abundances among sample methods. Namely, the spotfin shiner (*Cyprinella spiloptera*) dominated the seine samples of 1988 and 1990, but codominated with the

swallowtail shiner (*Notropis procne*) in both trap samples. *Notropis buccatus* and *N. rubellus* were more common in the semi-quantitative seine than trap samples, such that species diversities were similar for all four collections. Other forage fishes regularly above 5% abundance included *Luxilis cornutus* and *N. hudsonius*. These six abundant shiner species were also most abundant in the qualitative seine hauls of 1986-1987. The other five species analyzed were uncommon in all five fish samples.

Table 2. Percent abundance for nonrare (i.e., $\geq$ 3% in at least one of the four semi-quantitative samples) forage fish species in MGC during 1986-1988 and 1990. TR8687 and TR88 refer to predominately trapping data for 1986-1987 and 1988, respectively. SE88 and SE90 refer to 1988 and 1990 semi-quantitative, predominately seining data. SE8687 indicates the qualitative seining data of 1986-1987, enumerated by the total number of abundance points (does not add up to 100, see the text). The diversity index is Simpson/Levins index, and + indicates < 1.0% abundance. The factor axis of highest loading (r $\geq$ 0.84) for each sample is indicated by A = factor 1, B = factor 2, and C = factor 3.

Species	TR8687	SE8687	SE88	TR88	SE90
Cyprinella spiloptera	31	25	48	29	37
Exoglossum maxillingua	1	2	+	3	+
Luxilis cornutus	7	21	7	5	5
Nocomis micropogon	+	2	1	5	0
Notropis buccatus	1	13	13	2	8
N. procne	31	17	11	33	3
N. hudsonius	15	21	5	14	15
N. rubellus	3	15	5	+	9
Pimephales notatus	3	3	3	6	4
Lepomis auritus	+	1	1	+	5
L. macrochirus	0	1	0	0	5
# of fish collected	1319	---	12932	952	222
Diversity index	4.4	---	3.75	4.5	5.3
Factor axis	A	C	B	A	B

In summary, the results suggest some consistency in fish-assemblage structure across years, although the two major sampling techniques gave differing results. Apparently, the swallowtail shiner was more abundant in the trap samples because it was a shallow, slow-water

species (Vadas 1992), and thus more vulnerable to capture. All five samples nevertheless demonstrated the predominance of the spotfin shiner in the MGC forage-fish assemblage and the consistent importance of five other shiner species. Separation of the 1988 data by month revealed similar results (Vadas 1991). Both results together suggest that the MGC forage-fish assemblage has some degree of stability, but this hypothesis needs testing over several more years of data with consistent sampling techniques, preferably electroseining (cf. Angermeier et al. 1991).

Table 3. Percent abundance by station for nonrare (i.e., $\geq$ 3% in at least one of the three samples) forage and game fish species collected by electroseining during 1987-1991 (NF= North Fork, ML= middle-lower Goose Creek, and MGC= middle Goose Creek).

Species	NF	ML	MGC
Cyprinella analostana	2	10	0
C. spiloptera	26	17	5
Luxilis cornutus	0	8	+
Notropis buccatus	4	10	3
N. procne	24	9	4
N. hudsonius	4	7	5
N. rubellus	0	2	3
Pimephales notatus	14	14	0
Etheostoma blennioides	+	1	7
E. olmstedi	+	2	4
Catostomus commersoni	5	0	+
Hypentelium nigricans	1	1	3
Ambloplites rupestris	+	+	9
Lepomis auritus	5	4	33
L. macrochirus	9	4	1
Micropterus dolomieu	+	+	7
Fundulus diaphanus	0	+	5
# of fish collected	1516	1061	615
Diversity index	6.1	10.8	7.1

Fish Assemblages in Electroseined Samples

Percent similarity was moderately high (65%) for the two sixth-order sites (NF and ML), but moderately low (30-35%) between these two sites and MGC. The spotfin and swallowtail shiners codominated the North Fork sample, for which *Pimephales notatus* was subdominant (Table 3). All three of these cyprinids codominated with four other shiners in the mid-lower creek sample, such that species diversity was higher in the latter. The MGC sample was dominated by the redbreast sunfish, although fish species from several families were common enough to yield a moderately high species diversity. Notably, the list of important forage and game fish species for the two sixth-order samples were similar to those for the above MGC samples, again demonstrating the predominance of the spotfin shiner and redbreast sunfish. In contrast, the 1991 MGC electroseine sample was anomalous, showing relatively low abundances for the spotfin shiner and other cyprinids, perhaps because of predator or stress-caused mortality resulting from drought (Moyle and Li 1979, Grossman et al. 1982) and/or the small spatial scale of the 1991 sample (cf. Vadas 1991). The importance of the redbreast sunfish in this sample, however, did corroborate the MGC fly-fishing and other Potomac basin data discussed above.

Although the electroseine data are not directly comparable to the forage and game fish samples for MGC because of differences in sampling techniques, spatiotemporal scale of study, and/or stream size sampled, the data sets clearly showed some correspondence. There is some consistency in fish-species composition across space and time in the Goose Creek watershed.

Fish Assemblages in Boat-shocked Samples

Percent similarity was moderately low (40%) for the reservoir and stream samples, although centrarchids and cyprinids were respectively dominant and subdominant in both cases (Table 4). The redbreast sunfish and *Lepomis megalotis* codominated the diverse stream sample, whereas *L. macrochirus* dominated the undiverse reservoir sample. Two minnows and three sunfishes were subdominant in one or both collections, including the spotfin shiner and *L. macrochirus*. Clearly, game fishes dominated the boat-shocking samples, making comparisons with the MGC and electroseining samples difficult. The prominence of the spotfin shiner and redbreast sunfish in boat-shocked samples was nevertheless consistent with these other data.

Concluding Remarks

The discrepancies in species relative abundance among the various fish-collecting techniques used in Goose Creek highlight the importance of sampling with more than one method to establish fish-assemblage structure (Fausch et al. 1990, Vadas 1991). Trapping, fly-fishing, seining, backpack electroshocking, boat-shocking, and electroseining are differentially biased in the sizes and species of fish that they collect (Angermeier et al. 1991, Bryan 1984, Nielsen and Johnson 1983). For example, MGC darters were not efficiently kick-sampled except during the spring breeding season of *Etheostoma blennioides* (Vadas 1991). Kick-sampled quadrats also yielded most darters when subsequently electroshocked in the upper Roanoke River, southwestern Virginia (Vadas and Orth, unpublished data).

Table 4. Percent abundance of nonrare (i.e., $\geq$ 3% in either sample) game and forage fishes collected by boat-shocking during 1989 (LGC= lower Goose Creek and GCR= Goose Creek Reservoir).

Species	LGC	GCR
Cyprinella spilotpera	11	9
Cyprinus carpio	6	4
Pimephales notatus	9	0
Lepomis auritus	22	+
L. cyanellus	4	0
L. gibbosus	4	9
L. macrochirus	11	55
L. megalotis	17	1
Micropterus salmoides	2	10
Pomoxis nigromaculatus	2	7
# of fish collected	246	310
Diversity index	8.4	2.9

The importance of the spotfin shiner in Goose Creek may be of general ecological interest, as shiners such as the spotfin often breed later in the summer than other minnows, apparently allowing them to become dominant from lessened vulnerability to spring floods (Starrett 1951, Summerfelt and Minckley 1969). Although tuberculate males and ripe females were collected from mid-July to mid-August during 1987, spawning was most intense in flood-prone June of 1988 (Vadas, unpublished data). Dominance may instead result from drought resistance, as the spotfin and other *Cyprinella* spp. are often more tolerant of high temperature and reduced oxygen during summer than other MGC shiners, particularly the sensitive *Notropis rubellus* (Matthews and Maness 1979, Stauffer et al. 1974, RLV personal observation 1986-1990; but see Starrett 1950). Moreover, the spotfin's generalized feeding and habitat preferences in MGC (Vadas 1988, 1990, 1991, 1992) may be adaptive in streams with fluctuating flows (Moyle and Senanayke 1984), based upon general ecological theory (MacArthur 1965, Real 1980). Finally, the spotfin shiner, as well as many of the other abundant minnows (e.g., *Notropis buccatus* and *Pimephales notatus*) are expected to be common in mid-sized, sandy streams not subject to siltation problems (Mendelson 1975, Toth et al. 1982, Wallace 1972). In any case, the spotfin shiner and several other *Cyprinella* spp. are often dominant in warmwater streams with natural or anthropogenic perturbations (Lee et al. 1980, Matthews 1985, Maurakis and Woolcott 1984, Starrett 1951).

Despite the spotfin's dominance, there were several other consistently important species, including several other minnows and the redbreast sunfish. Given that the water quality and habitat structure of MGC are relatively pristine, abiotic factors such as floods, drought, and winter ice may not be severe enough to cause instability or reductions in species diversity in the fish assemblage (Calhoun 1957, Starrett 1951, Toth et al. 1982). The present study, as well as that of Vadas (1991), instead suggest that temporal changes in MGC's fish assemblage were not as drastic as predicted by Grossman et al. (1982) for warmwater streams in the United States.

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An Albino Snapping Turtle (*Chelydra serpentina*) From Calvert County, Maryland

Dwight Williams and Arnold Norden

All available information on the occurrence of albino amphibians and reptiles in Maryland was gathered by Harris (1968a, 1968b, 1970). Among all the new and previously published records given in those three papers, were records for albinism in only two local turtles, a painted turtle (*Chrysemys picta*) from near Upper Marlboro and a "partially leucistic" spotted turtle (*Clemmys guttata*) from near Croom, both in Prince George's County. The painted turtle was described as "chalk white in formaldehyde" (Cooper 1958, Harris 1970) and the spotted turtle was lacking dark pigment over about 60% of its body (Harris 1970).

Although the snapping turtle is one of our most common turtles, we are aware of only seven reports of albinism in this species (Dyrkacz 1981, Hensley 1959). Those reports include individuals from Florida, Illinois, Kentucky, Michigan, Ohio, and Ontario. On 18 September 1991, Jackie Marshall found an albino hatchling snapping turtle near Barstow in Calvert County. That individual lacks all dark pigment and is uniformly white (Figure 1). Although the pupil of the eye appears pigmented in Figure 1, it is actually pink in life. Therefore, according to the terminology used by Dyrkacz (1981) and Harris (1970), this turtle is a complete albino.

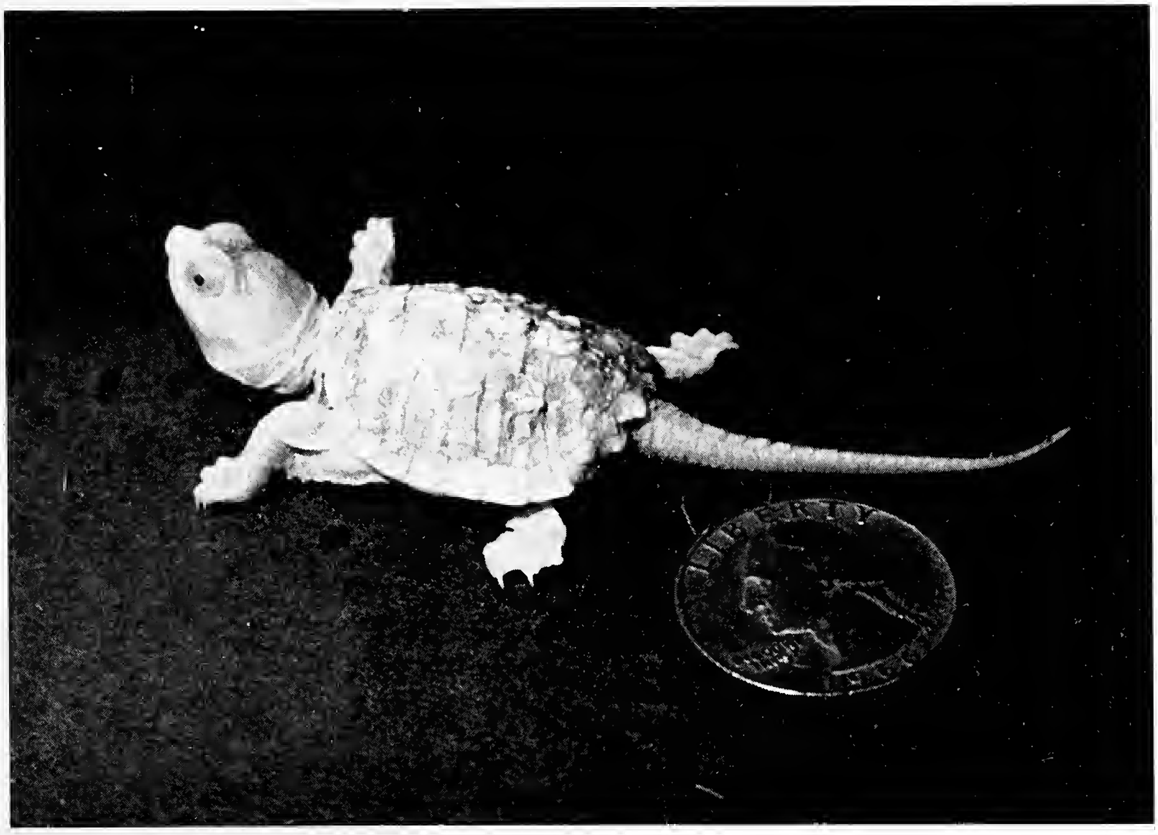

Figure 1. Albino snapping turtle from near Barstow, Calvert County, Maryland.

This snapping turtle, which was kindly donated to the nature center at the Battle Creek Cypress Swamp Sanctuary by Mrs. Marshall, is doing well and has a carapace length of 47mm, after ten months in captivity.

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EDITOR'S PAGE

From time to time we will be reprinting an older paper or article to increase the diversity of material included in *The Maryland Naturalist.* It is the intention of the editor to reprint only material that is little known, not easily accessible, interesting and still relevant. This issue includes "Maryland Meteorites", an article by Bryant Mather that was published in the *Maryland Naturalist* in 1954 (volume 24, numbers 1-4, pages 2-18). It appears on the following pages exactly as it was first published.

When this article was written, Mr. Mather was an Associate in the Department of Mineralogy of the Natural History Society of Maryland. The following information updating Bryant Mather's paper was provided by Dr. Roy S. Clarke, Curator of Meteors at the National Museum of Natural History, Smithsonian Institution. Dr. Clarke's assistance is gratefully acknowledged.

No additional meteorites have been found or reported to strike the ground in Maryland since Bryant Mather published this paper. All four known Maryland meteorites are listed in the Catalogue of Meteorites published by the British Museum of Natural History. The St. Mary's County meteorite was subsequently studied and discussed in detail in a paper published by Albert Noonan et al. in 1977, and both the Emmitsburg and Lonaconing meteorites were discussed by V. F. Buchwald (1975). As Bryant Mather noted, a fragment of the St. Mary's County meteorite was presented to the Maryland Academy of Sciences. That specimen, a fragment weighing 23.4 grams, was eventually transferred to the Smithsonian Institution in Washington. That is the fragment that was analyzed by Noonan et al. According to Dr. Clark, another 19.8 gram fragment of the same meteorite was also donated to the Smithsonian collection in 1977 by Mr. F. D. Cecil.

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Fig. 1

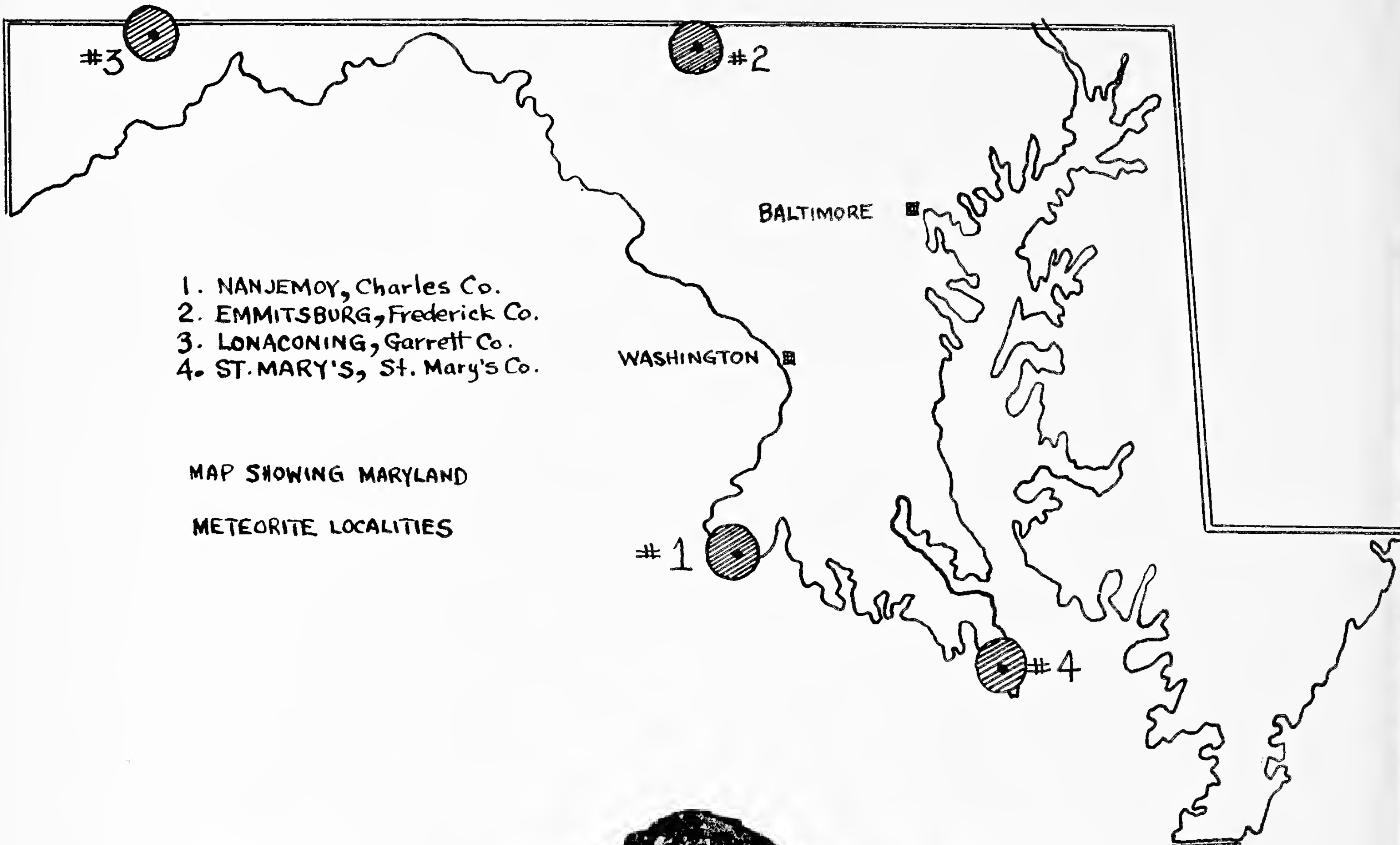
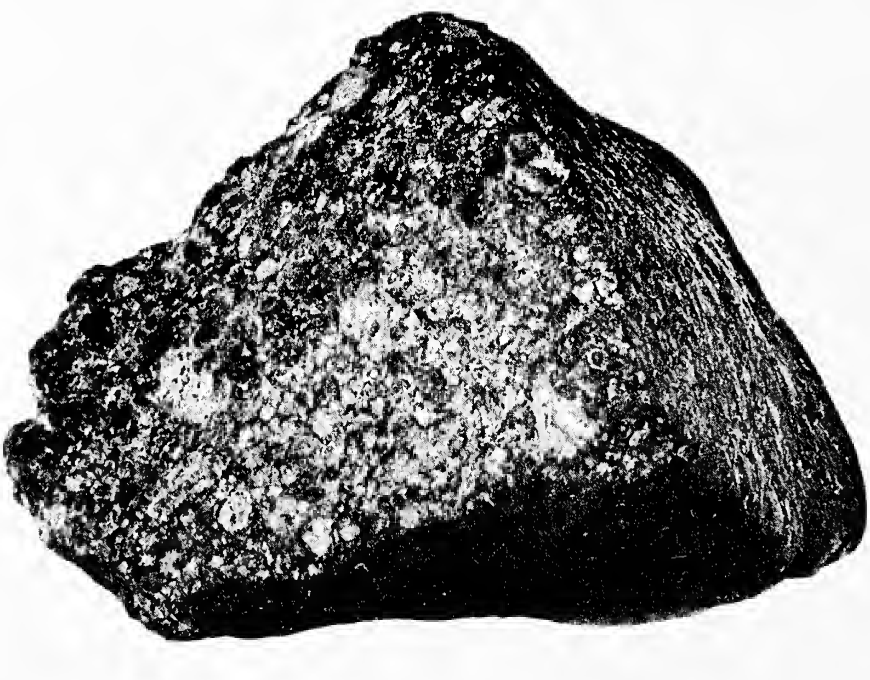


Fig. 2



FRAGMENT OF THE ST. MARY'S METEORITE

which fell near Ridge, Maryland
in June 1919

MARYLAND METEORITES

by BRYANT MATHER *

Seventeen years ago I had the pleasure of reporting (Mather, 1938) the discovery of the fourth authenticated meteorite from Maryland. Since, so far as I know, no additional occurrences have been reported since then, it seems appropriate to summarize the available information on Maryland meteorites with the primary purpose of stimulating interest in the subject to the end of adding to our knowledge. No previous summary of information on Maryland meteorites seems to have been published. The Pennsylvania Geologic Survey has issued an excellent bulletin (Stone, 1932) and additional articles (Stone, 1936) on Pennsylvania meteorites. No collection exists in Maryland in which samples of Maryland meteorites are displayed.

The four Maryland meteorites now known are listed below and their places of fall or discovery are indicated on the map (Fig.1):

	Name	Date	Discovery	Type	Weight, g	Location
1.	Nanjemoy	1825	Seen to fall	Stone	7599	Distributed
2.	Emmitsburg	1854	Ploughed up	Iron	177	"
3.	Lonaconing	1888	" "	"	1260	"
4.	St. Mary's	1919	Seen to fall	Stone	25	Md. Acad. Sci.

In this summary the available information on the authenticated occurrences will be presented and then information on several others that it was impossible to authenticate. It is hoped that others will pursue these and other accounts.

NANJEMOY

The Nanjemoy meteorite was seen to fall at noon on 10 February, 1825, near Nanjemoy in Charles County, Maryland. The locality is given as latitude 38 degrees 28 minutes north and longitude 77 degrees 16 minutes west. The reported weight was 7444 grams (16 1/2 pounds). The meteorite is a stone classified as a spherical chondrite (Class Cc of Brezina, or Luceite type 37, subtype 2 of Meunier).

The first account of this fall was given by Carver (1825) : "I take the liberty of forwarding you a notice of a meteoric stone which fell in this town on the morning of Thursday, February 10, 1825. The sky was rather hazy, and the wind southwest. At about noon the people of the town and of the adjacent country were alarmed by an explosion of some body in the air, which was succeeded by a loud whizzing noise, like that of air rushing through a small

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aperture, passing rapidly in the course from northwest to southeast, nearly parallel with the river Potomac. Shortly after, a spot of ground on the plantation of Capt. Wm. D. Harrison, a surveyor of this port, was found to have been recently broken, and on examination a rough stone of an oblong shape, weighing 16 pounds 7 ounces, was found about 18 inches under the surface. The stone when taken from the ground, about half an hour after it was supposed to have fallen, was sensibly warm, and had a strong sulphurous smell. It has a hard, vitreous surface, and when broken appears composed of an earthy or siliceous matrix of a light slate color, containing numerous globules of various sizes, very hard and of a brown color, together with small portions of brownish-yellow pyrites, which became dark colored on being reduced to powder. I have procured for you a fragment of the stone, weighing 4 pounds 10 ounces, which was all I could obtain. Various notions were entertained by the people in the neighborhood on finding the stone. Some supposed it propelled from a quarry 8 or 10 miles distant on the opposite side of the river, while others thought it thrown by a mortar from a packet lying at anchor in the river, and even proposed manning boats to take vengeance on the captain of the vessel.

"I have conversed with many persons living over an extent of perhaps 50 miles square; some heard the explosion, while others heard only the subsequent whizzing noise in the air. All agree in stating that the noise appeared directly over their heads. One gentleman, living about 25 miles from the place where the stone fell, says that it caused his whole plantation to shake, which many supposed to be the effect of an earthquake. I can not learn that any fireball or any light was seen in the heavens; all are confident that there was but one report, and no peculiar smell in the air was noticed.

"I herewith transmit the statement of Captain Harrison, the gentleman on whose plantation the stone fell:

'On February 10, 1825, between the hours of 12 and 1 o'clock, as nearly as recollected, I heard an explosion, as I supposed of a cannon, but somewhat sharper. I immediately advanced with a quick step about 20 paces, when my attention was arrested by a buzzing noise, resembling that of a humming bee, which increased to a much louder sound, something like a spinning-wheel, or a chimney on fire, and seemed directly over my head, and in a short time I heard something fall. The time which elapsed from my first hearing the explosion to the falling might have been 15 seconds. I then went with some of my servants to find where it had fallen, but did not at first succeed (though as I afterwards found I had got as near as 30 yards to the spot); however after a short interval the place was found by my cook, who had (in the presence of a respectable white woman) dug down to it before I got there, and a stone was discovered from 22 to 24 inches under the surface, and which, after being washed, weighed 16 pounds, and which was no doubt the one which I had heard fall, as the mud was thrown in different directions from 13 to 16 steps. The day was perfectly clear, a little snow was then on the earth in some places which had fallen on the night previous. The stone when taken up had a strong sulphurous smell, and there were black streaks in the clay which appeared marked by the descent of the stone. I have conversed with gentlemen in different directions, some of them from 18 to 20 miles distant, who heard the noise, not the explosion. They inform me that it appeared directly over their heads. There was no fireball seen by me or others that I have heard. There

was but one report, and but one stone fell to my knowledge, and there was no peculiar smell in the air. It fell on my plantation, within 250 yards of my house, and within 100 of the habitation of my negroes. I have given this statement to Doctor Carver, at his request, and which is as full as I could give at this distant day, from having thought but little of it since. Given this 28th day of April, 1825.'"

An analysis of the meteorite was made and reported by Chilton (1826) as follows: "The piece of Maryland aerolite subjected to examination weighed 228.30 grams and lost 62.25 grams by immersion in water at 60 degrees. Its specific gravity is therefore 3.66. The external crust was taken off and the remainder powdered, not very finely, and separated into two parts by the magnet; 25 of which were taken for examination. The same quantity was taken of the unmagnetical portion. The unmagnetical portion yielded:

SiO_2	Al_2O_3	MgO	CaO	FeO	NiO	S	Total
14.90	0.05	2.60	0.45	6.15	0.80	1.27 =	26.22

The magnetic portion yielded:

FeO	NiO	SiO_2	S	Total
24.00	1.25	3.46	Trace	28.71

A further account of the meteorite was given by Silliman (1826): "An excellent specimen, for which we are indebted to Dr Samuel D. Carver, weighs 4 pounds 5 ounces. Its dimensions are 7 by 3 by 4 inches; its form is that of an irregular ovoidal protuberance nearly flat where it was detached from the larger mass and bounded by irregular curves in the other parts of the surface. In all parts, except where it is viewed by a magnifier, it has more luster than is common. This coating is severed by innumerable cracks running in every direction and communicating with each other so as to divide the surface into polygons resembling honeycomb or madrepore, and no undivided portion of the surface exceeds half an inch in diameter. This circumstance is much less apparent upon the aerolites of Weston (1807), L'Aigle (1803), and Stannern in Moravia (1808); it appears to have arisen from the rapid cooling of the external vitreous crust after intense ignition. It is impossible to doubt that this crust is a result of great and sudden heat. In the Maryland aerolite it is not quite as thick as the back of a common penknife and, as in that of Weston and Stannern, it is separated by a well-defined line from the mass of the stone beneath. The mass of the stone is, on the fractured surface, of a light ash-gray color, or perhaps more properly of a grayish-white; it is very uniform in its appearance and not marked by that strong contrast of dark and light gray spots which is so conspicuous in the Weston meteorite. The fractured surface of the Maryland stone is uneven and granular, harsh and dry to the touch, and it scratches window decidedly, but not with great energy. To the naked eye it presents very small glistening metallic points and a few minute globular or ovoidal bodies scattered here and there through the mass of the stone. With a magnifier all these appearances are of course much increased. The adhesion of the small parts of the stone is so feeble that it falls to pieces with a slight blow and exhibits an appearance almost like

grains of sand. The metallic parts are conspicuous but they are much less numerous than the earthy portions which, when separated, are nearly white and have a pretty high vitreous luster, considerably resembling porcelain. They appear as if they had undergone an incipient vitrification and as if they had been feebly agglutinated by a very intense heat. I can not say that I observed in them, as M. Fleurian de Bellevue did in the aerolite of Jonzac (Journ. de Phys., tome 92, p.136), appearances of crystallization, although it is possible that there may have been an incipient process of that kind, especially as the small parts are translucent. The Maryland stone is highly magnetic; pieces as large as peas are readily lifted by the magnet and that instrument takes up a large proportion of the smaller fragments. The iron is metallic and perfectly malleable; although none of the pieces are larger than a pinhead, still they are readily extended by the hammer. The iron in the crust is glazed over so that the eye does not perceive its metallic character, but the file instantly brightens the innumerable points which then break through the varnish of the crust and give it a brilliant metallic luster at all the points where the file had uncovered the iron. The same is the fact with the Weston stone and with that of L'Aigle, but not with that of Stannern in Moravia; specimens of all of which and of the meteoric irons of Pallas, of Louisiana, and of Auvergne are now before me. The aerolites of Jonzac and of Stannern, as stated by M. Bellevue, are the only ones hitherto discovered that do not contain native iron and do not affect the magnet: still their analysis presents a good deal of iron which is probably in the condition of the oxide. The iron in the metallic state is very conspicuous in the Weston stone, sometimes in pieces 2 inches in length, and both in this stone and in that of Maryland it is often brilliant like the fracture of the meteoric iron of Pallas and of Louisiana. In the analysis of the Weston stone published in 1808 I did not discover chrome although it was afterwards announced by Mr. Warden. I have desired Mr. Chilton to reanalyze the Weston stone and he has nearly completed the labor. I am not quite sure that I discover pyrites in the Maryland aerolite, although it is mentioned by Dr. Carver in his letter in the preceding volume."

Partsch (1843) described the specimen of Nanjemoy in the Vienna collection: "Groundmass varying between light and dark gray, partly spotted with rust flecks; in part showing lighter but generally darker spherical inclusions firmly intergrown. There is a considerable sprinkling of iron and pyrrhotite. Crust rough and dull, broken by narrow clefts."

Shepard (1848) described it as follows: "Its crust resembles that of the Iowa stone (Marion), without, however, possessing its uniformity of thickness or its deep black color. The proportion and mode of dissemination of the nickel iron and of the pyrites is very similar in both; but the color of the earthy mineral in the Maryland is several shades darker and more inclined to blue. The iron-rust points are fewer than in the Iowa meteorite. Like the latter it is principally composed of Howardites; although rounded grains of olivinoid to the amount of perhaps 15 per cent are distinguishable with the aid of a microscope."

Meunier (1884) recalculated Chilton's analysis to percentages and gave it as follows: Nonmagnetic portion:

SiO_2	MgO	CaO	Fe_2O_3	NiO	Al_2O_3	S		Total
59.6	10.4	1.8	24.6	3.2	0.2	5.08	=	104.88

Magnetic portion: $SiO_2+MgO+CaO$: 13.84, Fe : 96.00, Ni : 5.00 = 114.84

He also gives the specific gravity, according to Rumler, as 3.6062.

Brezina (1885) classed the Nanjemoy meteorite as a gray chondrite. In 1895 he removed it to the class of spherical chondrites and stated: "The Vienna specimen shows an inclination to Cc; the two pieces in the Tubingen collection of 100 and 82 grams weight, both with crust, show a decided spherical chondritic structure with a slaglike crust up to 2.5 mm in thickness."

The meteorite is distributed in a large number of collections. If we assume that the original weight was approximately 7599.35 grams (= 16 pounds 7 ounces; not "16.7 ounces" as stated by Merrill (1916) and that 228.3 grams were used by Chilton in analysis, there remains 7371 grams to account for The following museum specimens are listed in order of weight.

Location	Weight, g.	Reference
Yale University, New Haven, USA	897	Farrington (1915)
Vienna, Austria	351	Wulfing (1897)
British Museum, London, England	325	Prior (1923)
London P.G., England	237	Wulfing (1897)
Tubingen, Germany	182	Brezina (1895)
Harvard University, Cambridge, USA	123	Huntingdon (1887)
Chicago Museum of Natural History, USA	106	Farrington (1916)
Budapest, Hungary	93	Wulfing (1897)
Geol. Survey of India, Calcutta	70	Brown (1914)
Copenhagen, Denmark	66	Wulfing (1897)
U.S.National Museum, Washington, USA	44	Merrill (1916)
Berlin, Germany	33	Rose (1864)
Amer. Museum of Nat. History, N.Y., USA	30	Reeds (1937)
Gottingen, Germany	9	Klein (1879)
Philadelphia Acad. Nat. Sci., USA	7	Gordon (in litt.)
Leningrad, Russia	6	Wulfing (1897)
von Braun collection	5	"
Paris, France	4	Meunier (1897)
Strasburg, Germany	2	Wulfing (1897)
von Siemaschko collection	2	"
Total accounted for :	2592	
Unaccounted for:	4779	
Total:	7371	

EMMITSBURG

The Emmitsburg meteorite was found in 1854 near Emmitsburg in Frederick County, Maryland. The locality is given as latitude 39 degrees 42 minutes north and longitude 77 degrees 19 minutes west. The original weight is not reported and only 177 grams seem to be accounted for. The meteorite is an iron classified as a medium octahedrite (Class Om of Brezina).

In contrast to the careful and detailed accounts of the finding of the Nanjemoy meteorite, nothing at all seems to have been written of the finding of the Emmitsburg meteorite. The first reference seems to be by Brezina (1885) in which he mentions it as the representative of the "Emmitsburg Group" of octahedrites with medium lamellae. He gives the characteristics of this group as: "Lamellae straight, grouped, not very long; kamacite dark gray, hatched, in part spotted, with plain though not very strongly oriented sheen. Rhabdite very abundant, at times on the edges of the field taking the place of taenite. Width of lamellae 0.6 mm." In his 1895 catalog, Brezina remarks that Emmitsburg much resembles Plymouth. I have used the spelling "Emmitsburg" as given in the United States Postal Guide; the spelling used by Brezina is "Emmetsburg."

The distribution of the accounted for 177 grams is as follows:

Chicago Museum of Natural History, USA	64	Farrington (1916)
American Museum of Natural History, N.Y.,USA	49	Reeds (1937)
U.S.National Museum, Washington, USA	27	Merrill (1916)
Harvard University, Cambridge, USA	10	Huntingdon (1887)
Vienna, Austria	9	Wulfing (1897)
British Museum, London, England	7	Prior (1923)
Dresden, Germany	2	Wulfing (1897)
Other collections	9	"

Prior (1923) in the British Museum catalog states that a mass weighing about one pound passed into the possession of Dr. J. R. Chilton of New York from whom S.C.H. Bailey obtained specimens as is indicated by a letter dated 7 January 1885 from S.C.H. Bailey that is in the files of the British Museum (Natural History) Mineralogy Department.

LONACONING

The Lonaconing meteorite was found in 1882 in Garrett County, Maryland not far from Lonaconing, Allegany County. The locality is given as latitude 39 degrees 35 minutes north and longitude 78 degrees 38 minutes west. The original weight was 1260 grams (45 ounces). The meteorite is an iron classified as a coarse octahedrite (Class Og of Brezina).

The meteorite was described by Foote (1892) as follows: "A physician residing near the Maryland line of Pennsylvania recently brought to me an iron mass to learn if it was meteoric, and this it proved to be. It was discovered in Garrett County, Maryland, about 12 miles from the post office of Lonaconing, not far from the Pennsylvania border. It was ploughed up about three or four years ago by a boy in the field. According to an analysis by Dr. Koenig it contains over 11 per cent of nickel and cobalt, the proportion of cobalt being unusually high. It is one of the best octahedral etching irons known, being even more characteristic than most of those that have been used for printing directly on paper. Besides the striking reticulated octahedral structure, it shows a large number of secondary lines regularly disposed with reference to the principal markings. These I believe to be similar to those described by Prof. J. Lawrence Smith, in a Wisconsin meteorite, under the name of Laphamite markings. The original weight was 45 ounces, but it has been reduced by analysis, cutting, polishing, etc. to 36.5 ounces."

Brezina (1895) described the meteorite as follows: "An iron of 1.2 kg. weight, in the form of an elliptical cylinder with slightly bent axis. The section shows along the natural surfaces a finely flecked zone of alteration 2 to 9 mm thick. The lamellae are puffy, taenite well developed, fields predominant, almost entirely filled with a repetition of systems of combs running in many different directions in the same field; field less frequently filled with a dark gray plessite. Two large plessite areas show finely shimmering central skeletons. Cohenite grains sometimes occur isolated in the kamacite. The kamacite bands are slightly granular, the kamacite combs much so."

The reported distribution of the meteorite is as follows:

Location	Weight, g.	Reference
School of Mines, Paris, France	750	Farrington (1916)
American Museum of Nat. Hist., N.Y.,USA	123	Reeds (1937)
British Museum, London, England	74	Prior (1923)
Chicago Museum of Nat. Hist., USA	39	Farrington (1917)
Vienna, Austria	33	Wulfing (1897)
Total accounted for:	1019	
Unaccounted for:	16	
Total	1035 (= 36.5 ounces)	

ST. MARY'S

The St. Mary's meteorite was seen to fall at about 6 P.M. on or about 20 June 1919, near the town of Ridge, St. Mary's County, Maryland. The weight of the fragment that is known to exist is 24.25 grams. The meteorite is a stone classified as a spherical chondrite.

The existence of the meteorite was recorded in the card catalog of the U. S. National Museum on 9 December 1937 and in the minutes of the Baltimore Astronomical Society for 10 January 1938. The first account was given by Mather (1938) as follows: "It is the purpose of the present paper to give a preliminary notice of the finding of the fourth meteorite from Maryland. In connection with a search by the author for reports of Maryland meteorites, he was, in October 1937, directed to Mr. Francis D. Cecil of the Astronomical Section of the Maryland Academy of Sciences. From Mr. Cecil there has been obtained considerable data and a fragment of a meteorite. This meteorite is to be known as the St. Mary's meteorite and is known to have fallen on or about June 20, 1919 at approximately 6:00 P.M. near the town of Ridge, St. Mary's County, Maryland. The meteor was observed in the sky by many persons and was seen to explode, the fragments appearing to settle slowly to the earth, most of them apparently falling into the Chesapeake Bay. The fragment which is the property of Mr. Cecil is a portion of a larger mass which has apparently been lost. The fragment available for study is roughly pyramidal consisting of three natural surfaces and one broken surface. These surfaces are roughly triangular and from 30 to 40 mm on an edge.

The fragment weighs 24.25 grams and has a specific gravity of 3.24. It is solid and compact. On the natural surfaces there is a thin black fused coating such as is frequently found on stony meteorites, and these surfaces are quite smooth. On the broken surface, the fresh meteorite is seen to have a dark gray color and an oolitic-like texture. This texture is due to the meteorite being composed of chondrules and phenocrysts, the size of these megascopically ranging from tiny points up to nearly 2 mm. It has been suggested that the meteorite is composed chiefly of enstatite and olivine. It is interesting to note that these two minerals have specific gravities of 3.1-3.3 and 3.27-3.37 respectively and that their average specific gravity is 3.26 whereas that observed for the meteorite is 3.24. This fact would tend to support the assumption that if iron is present it is certainly in only a very small percentage. The fall was witnessed by Mr. James Cecil of Washington, D.C., Mrs. Joseph B. Cooper of St. Mary's County and many others. According to Mr. Francis Cecil and others with whom he has talked the meteor swept across the late afternoon sky from southwest to northeast and had the appearance of a giant fireball. It was described by Mr. James Cecil as fiery red in appearance and about the size of a canteloupe or about 1/4 degree in diameter. Another person who witnessed the event is reported to have been up in a cherry tree eating black-heart cherries and when the meteor flew across the sky and exploded he was extremely terrified and thought the end of the world was at hand. This observer said that the path of the fireball was from southwest to northeast. According to all observers the meteor exploded with great violence and the noise accompanying this explosion was heard by a very large number of persons. The man in the cherry tree stated that, following the explosion, there was in the sky a trail of smoke which seemed to him to be about four city blocks in length. It was also heard by the aunt of Mr. Francis Cecil, Mrs. Joseph B. Cooper, who dates the occurrence by the fact that it was a little less than two weeks before her marriage, which took place on June 30, 1919. She also remembers the heavy layer of black smoke which was visible in the sky following the explosion. Mr. Francis Cecil himself remembers distinctly the explosion and the long rumble which followed it, and records that its violence was sufficient to shake the window panes of the store at Great Mills where he happened to be at the time. Other persons have said that plates on shelves were shaken. A few days after the meteor had exploded, Captain John Forrest, who died in the winter of 1935, came to Mr. Cecil's grandfather with what he described as a piece of the meteorite that had fallen a few evenings previously. He said that he had seen the event, had heard the explosion and that a piece of the rock had fallen from the sky and struck up the dust immediately at his feet. He said that he at once dug the object up and found it very hot. After it had cooled off he broke off a small piece which he gave to Mr. Cecil's grandfather, which is the piece now available for study. Repeated efforts by Mr. Cecil to locate the larger portion which had been kept by Captain Forrest have proved fruitless. Captain Forrest is reported to have said that as he watched it after the explosion the fragments appeared to settle to the earth through the sky and appeared to fall mostly into the Chesapeake Bay. It would seem likely therefore that the explosion must have taken place at a rather considerable height. Captain Forrest's home was located about one mile from St. Jerome's Creek near Ridge. The specimen was shown to Dr. W. F. Foshag of the United States National Museum on December 9, 1937 who stated: "I can definitely say that there is not the slightest doubt but that the specimen is a meteorite." Mr. Cecil has conferred with the widow and the son of Captain Forrest, both of whom knew of

the meteorite and of the event of its fall, yet neither could give any data as to the present whereabouts of the larger fragment; although they both remembered seeing it as recently as 1933."

The second notice of this meteorite was given by Dulaney (1938) from which the following is quoted: "One of four Maryland meteorites recorded has been presented to the Maryland Academy of Sciences by Frank Cecil.... the story of its fall is as follows: About 6 P.M. one day in June 1919, residents of St. Mary's county were startled by a ball of fire streaking across the clear sky. The ball exploded and red-hot fragments settled earthward. Then followed a series of rumbling sounds like distant thunder. Buildings in a radius of ten miles were jarred and shaken. John Forrest, working in a field adjoining his home, saw the meteor and, as he watched, something struck up a cloud of dust 20 feet from where he stood. Going to the spot he dug into the ground and unearthed a gray-brown stone, very hot, which he carried on his hoe to his house and placed it aside to cool. Three days later he gave it to William Matthews, who in turn presented it to Mr. Cecil...... It is magnetic, a characteristic possessed by no earthly stone."

The St. Mary's meteorite was included in the Second Catalog of Meteoritic Falls Reported to the Society for Research on Meteorites (Nininger, 1939). A previously unpublished photograph of the specimen, obtained from Mr. Cecil, which shows the structure on the broken surface, is given as Fig. 2.

UNVERIFIED AND DISCREDITED REPORTS

Discredited and unverified accounts of the fall or finding of meteorites arise generally in one of the following ways: Reports of the finding of iron meteorites often turn out to be finds of lumps of iron or iron ore of clearly terrestrial origin, or of other dark heavy rocks. Reports of the finding of stone meteorites often turn out to be finds of dark, heavy igneous rock fragments. Such reports are especially frequent in glaciated areas. Reports of falls come in two classes: (a) where something was thought to fall but did not; (b) where something fell but was not a meteorite. Those of the former type include those based on sight and sound. The commonest result from the observation of a meteor that appears to fall at a distance from the observer. Such observations usually are of meteors that do not reach the earth. Reports based on sound usually involve explosions, the cause of which is not known to the hearer. Those of the second type include various situations ranging from rocks thrown by small or not-so-small boys to projectiles, objects dropped from aircraft, missiles projected by firearms or by explosions as in blasting. The most tantalizing reports are those based on recollections of the past or recollections of information received second hand. Examples of several of these sorts of reports as they were found in my survey of Maryland meteorites are given below:

CAMBRIDGE

Mr. J. Maurice Bowser informed me that in the summer of 1934 he discovered a heavy object, about the size of a man's fist, in a marsh in the

Black Water Migratory Bird Refuge, about 13 miles south of Cambridge, Maryland. Mr. Bowser thought that this was an iron meteorite. It was found on the surface of the earth and had a "pimply" or blistered surface texture. He stated that he had given it to the Superintendent of the CCC camp, Mr. Peter J. Van Huizen. I wrote to Mr. Van Huizen at the Sacramento Migratory Wildlife Refuge, Willows, California, on 11 October 1938 but received no reply. I suspect that the object in question was iron ore.

SIDELING HILL

On 9 June 1938 I wrote to Dr. Ralph W. Stone of the Pennsylvania Geological Survey, Harrisburg, Pennsylvania to ask if he had any reports of Maryland meteorites. Dr. Stone replied on 13 June 1938 as follows: "Only one meteorite in Maryland was reported to me and that at least five years ago. One of our legislators from Fulton County told me that some years prior a supposed meteorite was found by Jacob Nixon, whose son then had a road stand, called Forest Park, between Hancock and Cumberland. The park was described as near Bellgrove, on Sideling Hill. That is every bit of information on the subject; no mail address and no description of find. Chances are probably 100 to 1 that it is not a meteorite and now is lost anyhow." No further information on this report has developed.

EMMITSBURG NO. 2

In 1937, Mr. T. Milton Oler, Jr., 542 Tyson Street, Baltimore, informed me that he was acquainted with Mr. J. K. Hays of Emmitsburg, Maryland in whose yard a meteorite had fallen. Mr. Oler offered to talk to Mr. Hays and report to me. He wrote to me on 10 November 1937 as follows: "I have talked with Mr. Hays since I last saw you and the following is his description of the falling of a meteorite in his yard in Emmitsburg. About the year 1897, on a midsummer evening shortly after dark, Mr. and Mrs. J. K. Hays, their young son and Mr. Hays' mother were sitting on the porch of their home on the outskirts of Emmitsburg, Md. Mr. and Mrs. Hays both saw the meteorite at the same time as it fell on a course almost paralleling the earth and proceeding from west to east. It landed in their yard about 100 yds. from the house and was still red hot when they reached it. One of the things Mr. Hays particularly remembers was his infant son telling his grandmother 'it was hot stone' when they returned to the house. The meteorite was of an oval shape with a long diameter of about 8" and a short diameter of about 4" and had the appearance of a large clinker. It was very heavy considering its size but there is no record of its weight. It sank in the ground about 6" but the fact that the earth was baked hard from a long spell of extremely dry weather probably accounts for this slight penetration. The meteorite was in the possession of Mr. Hays until a few years ago and Mr. Hays daughter remembers seeing it resting on a shelf in the cellar for years. As to its present location, no one seems to know what happened to it. Mr. Hays thinks that his son threw it out. There is a possibility that a fragment was given to the Sisters at the College in Emmitsburg and they may be able to give you additional information."

Following Mr. Oler's suggestion I wrote to St. Joseph's College and under date of 23 November 1937 received the following reply from Sister Lucille, Principal, St. Joseph's College High School, Emmitsburg, Md.: "As

the Museum is located in the high school buildings your letter was sent to us. We have searched for the piece of meteorite; likewise for information regarding same, but to date our search has proved futile. I suggest your writing to the Fathers at Mount Saint Mary's College, Emmitsburg; also to Mr. J. T. Hays, Box 168, Emmitsburg. I am told that in his home there is a piece of metal, leaden color speckled with gold which is being used as a door knob. This is treasured by the family. Could it possibly have bearing on that for which you are searching?"

I then wrote to Mount Saint Mary's College and under date of 8 December 1937, received the following reply from Rev. J. L. Sheridan, President: "We regret very much that prolonged search for the information sought in your letter of 24th ultimo failed to produce results. A gentleman who was present when the meteorite fell in the Hays' yard tells us that it could not be found. As to the former (1854) meteorite we have no data either. Sorry, indeed that we cannot be of service, as the subject is of much interest to us too." The reference to a second witness was of considerable interest, so I wrote Father Sheridan for more information about him. Father Sheridan's reply was: "The name of the gentleman who was with Mr. Hays on the occasion is Harry Weant, Emmitsburg, Md. He is our plumber. I think however that you can learn nothing more than we wrote you. He told us all he could - and that was very little from a scientific point of view. I should be grateful for the brochure you hope to publish. Many thanks. With every good wish for your success." I received no replies to letters addressed to Mr. Hays. I then made inquiry of Miss Leah B. Allen, Williams Observatory, Hood College, Frederick, Md., who wrote to me on December 8, 1938 as follows: "I have written to a Hood alumna whose home is in Emmitsburg to ask her if she has heard anything of the missing meteorite, I'll let you know if I can get any information on the subject." This is where the trail ended as far as I was concerned.

ROCK HALL

An Associated Press dispatch from Rock Hall, Md., dated March 2, 1935, published in the *Baltimore Evening Sun* of that date reads: "Meteorite Found on Shore Farm: A large meteorite has been dug up and is now on display on the farm. The mass is thought to be iron. Many pebbles are imbedded in it; the weight of the object is about 200 pounds. The farm on which it fell is owned by Louis Aiello of Baltimore and Rock Hall and is tenanted by John Usilton. The 'meteorite' has been placed on a cement foundation in front of the house. A. Carroll Wilson, who occupies an adjoining farm, has said that on the night of a snowstorm recently he heard a rumbling noise and thought it was caused by the firing of the big guns at the Aberdeen Proving Grounds. The next morning it was discovered that a large pine post near where the mass fell had burned."

I wrote to Mr. Louis Aiello, c/o Louis Aiello & Son, Inc., 3700 Gough Street, Baltimore, on 3 June, 1938 and received the following reply dated 16 June 1938, from Mr. Peter Aiello, President: "My father Louis Aiello, died last November, therefore I am answering your letter with reference to the 'meteorite'. There is an object that looks like furnace slag placed in front of our farm dwelling at Rock Hall, Maryland and thats all the information I can give you. If you care to examine it, you may do so by going there. Anyone at Rock Hall will be able to tell you where our place is located." I was never able to get to Rock Hall nor to obtain any more information. The reference to imbedded pebbles, to looking like furnace slag,

and to the burned post all suggest that the object is not a meteorite. It should however be checked.

WYMAN PARK

In 1935 a piece of iron was brought into the Geology Department of the Johns Hopkins University. It was stated to have been found in Wyman Park, Baltimore, and was suspected of being a meteorite. Chemical tests indicated that it contained no nickel. Etching a sawed surface revealed no characteristic etch figures. Prof. J. D. H. Donnay concluded that it was not a meteorite and might have been the result of some iron object melted in the University furnace, included with the cinders that were used on a path.

LOGAN FIELD

The *Baltimore Evening Sun* for 16 October 1934 carried the following account: "Piece of Giant Meteor Found at Logan Field: Fragment Weighing More Than Half a Pound Discovered in Search Following Flash and Whir Overhead Last Night: One piece of the giant meteor which flashed across the heavens from the eastern part of Baltimore county and disappeared after being sighted by persons at Logan Field and Ellicott City, headed in the general direction of Westminster, was found today on a runway at the Logan Field airport. L. M. Rawlins, manager of the airport, was present last night when a fragment of the meteor hissed through the air and fell on the landing field. However, before he and others who had also witnessed the oddity could reach the spot where the object had landed, it had burned out and disappeared in the blackness of night. This morning, after a search of the vicinity, a section weighing nearly half a pound was discovered on a runway of the field. Dr. J. G. H. Donnay, associate professor in mineralogy at Johns Hopkins University, was notified and came to the field. Under the microscope the portion was examined and a piece of it was taken by the mineralogist back to the university for further study. 'We saw it flash by at about 9:30 last night', said Mr. Rawlins. 'It had a tail several feet long and we could see it strike the earth apparently almost at our feet,' he added. Chief Julius Wosch, of the Ellicott City police, reported that while standing on a street corner there, the meteor passed through the air high overhead. 'It moved with terrific speed, and made a sizzling noise as it passed,' he said. He added that it disappeared in the direction of Westminster." Another article in *The Sun* gave a similar account, quoting Chief Wosch to the effect that he was with Charles Gendason of Ellicott City at the time and saying that "it burst into flames over Westminster" and that he saw it at 9:25 p.m., that it had "a blue center and a red rim." It was also said to have been seen in Westminster by Paul Wimert, "where it burst into white flames and disappeared." The fragment examined by Prof. Donnay was not a portion of a meteorite.

HAMPDEN

A letter dated Baltimore, September 20, 1869, addressed to Mr. P. T. Tyson from Mr. Charles F. Hanna, preserved in the letter file of the Maryland Academy of Sciences, records that: "At 7:20 p.m. on Aug. 13, 1869, on Falls Road, north of Hampden, I saw an object approaching from the east. When it was 30 feet off the ground it disgorged. I thought it was a rocket from Schutzen Park on Belair Road. It landed with a thud that was heard by seven

people. It was 15 feet 6 inches long. Five minutes later it was perfectly white, it writhed like a serpent. It later thinned and 15 minutes later diffused into the air. It was also seen from Mount Washington. It was seen by others."

WESLEY AVENUE, BALTIMORE

The *Baltimore Evening Sun* for May 12, 1936 carried an article from which the following is quoted: "Meteor Evidence Lacking in Blast: Some Wesley Avenue Dwellers Think That's What They Heard Last Night: A first class mystery presented itself to residents of the 5500 block Wesley Avenue today as they compared notes on what happened late last night when a blinding flash and loud explosion startled home-owners in the neighborhood....Some thought a falling meteor might be responsible. Edward W. Berry, 5512 Wesley Avenue, told police that he and his mother-in-law, Mrs. Jane Lee Selby, were sitting in the front room, looking out toward the rear yard through a dining-room door when suddenly, without warning there was a blinding flash, a loud explosion that 'sounded like dynamite.' Berry said he ducked his head instinctively. He looked up almost at once however and said he saw the light fading out. The flash he said was 'bluish, whitish, and greenish.'..... Berry said the explosion was loud enough to shake his house and rattle the windows. Officials of the gas and electric company checked up and said that a street light had burned out last night on Wayne Avenue, in the 5200 block, a couple of blocks from Wesley Avenue. This might have caused a flash, but there was nothing to show that it could have caused a loud noise."

BALTIMORE

Dr. W. F. Foshag, Curator of Mineralogy and Petrology at the United States National Museum in Washington, D. C. wrote me on 1 November 1937 as follows: "Some time in the spring Wise and Moore brought me some of the supposed meteoric specimens but these proved to be nothing more than nodules of limonite. I believe they had taken them previously to the U.S. Geological Survey where some one reported they were possibly meteoric. Our examination shows that there is nothing meteoric about them."

METEORS

Meteor showers have frequently been observed in Maryland, especially in Baltimore. A large shower occurred on the morning of 12 or 13 November 1833. The *Baltimore Patriot* and Niles Weekly *Register* report that it began at 4:30 a.m. and lasted over 50 minutes. During this shower, a meteor estimated as having a diameter of at least six inches was seen to explode over northwest Baltimore with a loud report. The *Baltimore Gazette* and the *Baltimore American* also report this shower. It is reported that Thomas Kenny watching from the corner of Charles and Fayette streets found the sight especially wonderful, having seen one meteor describe a figure three before burning out. In many succeeding years the annual meteor showers early in August - the Perseids - and in mid-November - the Leonids, and occasionally others attract sufficient attention to justify notice in the press. Rarely is the fall of a meteorite associated with such a shower of meteors An Associated Press dispatch from Annapolis, Md. as published in the *New York*

Sun for 4 May 1945 reports that Captain H. E. Avery of the Maryland Pilots Association said he saw today a blue ribbon of light about twenty feet wide with drifting fragments in the Chesapeake Bay. Captain Avery said he was in his cabin cruiser Lone Eagle in Annapolis Harbor at 3:40 a.m. when he saw the ribbon of light, which he said lighted up the whole sky and seemed to fall in the north. He added that a loud 'whoosh' accompanied the light, but he heard no sound of a falling object. He said that he noticed the phenomenon in what appeared to be the vicinity of the Marine barracks ship Reina Mercedes. Other reports from the middle Atlantic states that day included the statement by Dr. Roy K. Marshall, director of the Fels Planetarium at the Franklin Institute in Philadelphia that the object was probably a "bolide, the largest kind of meteor."

METEORITE SPECIMENS IN MARYLAND

As has been previously indicated, the known fragment of the St. Mary's meteorite remains in the state of Maryland. If specimens of the other three known Maryland meteorites are to be seen, a Marylander must go at least as far as the National Museum in Washington. The collection of the Geology Department of the Johns Hopkins University contains specimens of seven meteorites:

1. Weston, Connecticut (two small fragments, donor Maryland Academy). The first observed and described meteorite fall in North America.

2. Canyon Diablo, Arizona. (one large individual weighing about 100 pounds, gift of Dr. Howard A. Kelly; and one very small fragment; the meteorite from "Meteor Crater".)

3. Nelson County, Kentucky.

4. Russel Gulch, Colorado

5. Marion, Linn County, Iowa.

6. Toluca, Mexico (three pieces of the meteorite of which at one time it was said that there were a larger number of pieces than of any other.)

7. Mocs, Transylvania (one of about 3000 stones that fell February 3, 1882).

It is also interesting to note that in 1939 Dr. Howard A. Kelly also presented to the observatory at Vassar College a meteorite from Canyon Diablo (Meteor Crater) Arizona. (*Baltimore Evening Sun*, April 12, 1939).

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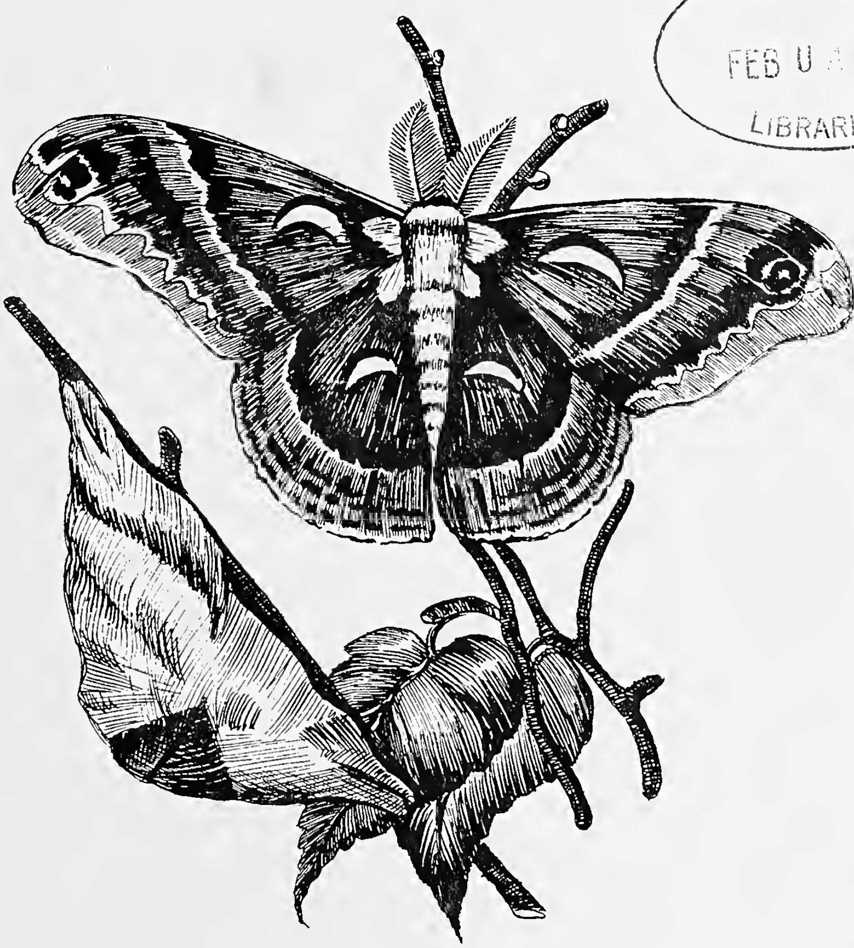

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Arnold W. Norden, Editor

Mailing Date: 31 December 1992

Cover Illustration: The Cecropia Moth (*Hyalophora cecropia*), shown here with its cocoon, is one of our largest (wing span to 15 cm) and most spectacular insects. This pen and ink sketch was probably done by Edgar C. Gretsky, who was an artist at the Natural History Society of Maryland from the 1930's to the 1950's.

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The Maryland Naturalist 36(2-4):1-8 July/December 1992

Larval Mussel Parasitism of Fishes in the Potomac River Estuary, Fairfax County, Virginia

Evelyn M. Ernst

Introduction

Freshwater mussels of the family Unionidae have a highly modified larva, the glochidium, which is an obligate parasite on the gills, fins, or skin of certain freshwater fishes. Glochidia are released into the water from the marsupia of the female mussel. After locating and attaching to a suitable fish host, the glochidium becomes encysted. While encysted, it metamorphoses to the juvenile stage (Zale and Neves 1982a). At the end of the parasitic phase the young mussel breaks out of its cyst, falls to the bottom, and enters a free-living juvenile stage (Pennak 1978). This combination of parasitic larva with free-living adult is unusual in parasitic organisms; this parasitism is also unusual in that the Unionidae are the only members of the Class Bivalvia known to have obligate parasitic larvae (Kat 1984).

The presence of a suitable host at the appropriate time is a critical factor in the life cycle of mussels. Host fishes have been identified for only 20 to 25 percent of the North American species of unionaceans (Fuller 1974; Hanek and Fernando 1978a, b; Stern and Felder 1978; Trdan and Hoeh 1982; Zale and Neves 1982b; Threlfall 1986). Fish hosts have been reported for only seven of the 19 species of Unionidae (six of which are endangered or of special concern) thought to occur in the Potomac and Rappahannock drainages in northern Virginia.

Materials and Methods

Fish were collected by trawling at five sites in the Potomac River estuary in Fairfax County, Virginia (Figure 1); two sites (1, 2) in Gunston Cove, one (3) in Dogue Creek, and two (4,5) in the Potomac River. Gunston Cove is located along the south side of the Potomac River approximately 18 miles SSW of central Washington D.C. Collections were made on 2 and 19 September, 19 October, and 16 November, 1988. One hundred twenty-six fish representing 13 species from eight families were examined (Table 1): Atherinidae (1 species), Centrarchidae (2), Clupeidae (2), Cyprinidae (3), Engraulidae (1), Percidae (2), Percicthyidae (1), Sciaenidae (1).

Fish were fixed in 10% formalin and transferred to 70% ethanol. Each was identified to species, measured, and examined under a zoom stereoscopic microscope for encysted glochidia on the gills, fins, and skin. Gills were excised for examination. To facilitate identification, encysted glochidia were removed from host tissue by placing small sections of infested tissue in 1-2 ml of 5.25% sodium hypochlorite solution for several minutes. Glochidia removed by this procedure were then examined and photographed under a compound microscope. General shell shape and the presence or absence of a hook were noted. Glochidial measurements, when possible, included length, the maximum anteroposterior dimension parallel to the hinge; breadth (or height), the maximum dorsoventral dimension perpendicular to the hinge; and hinge length.

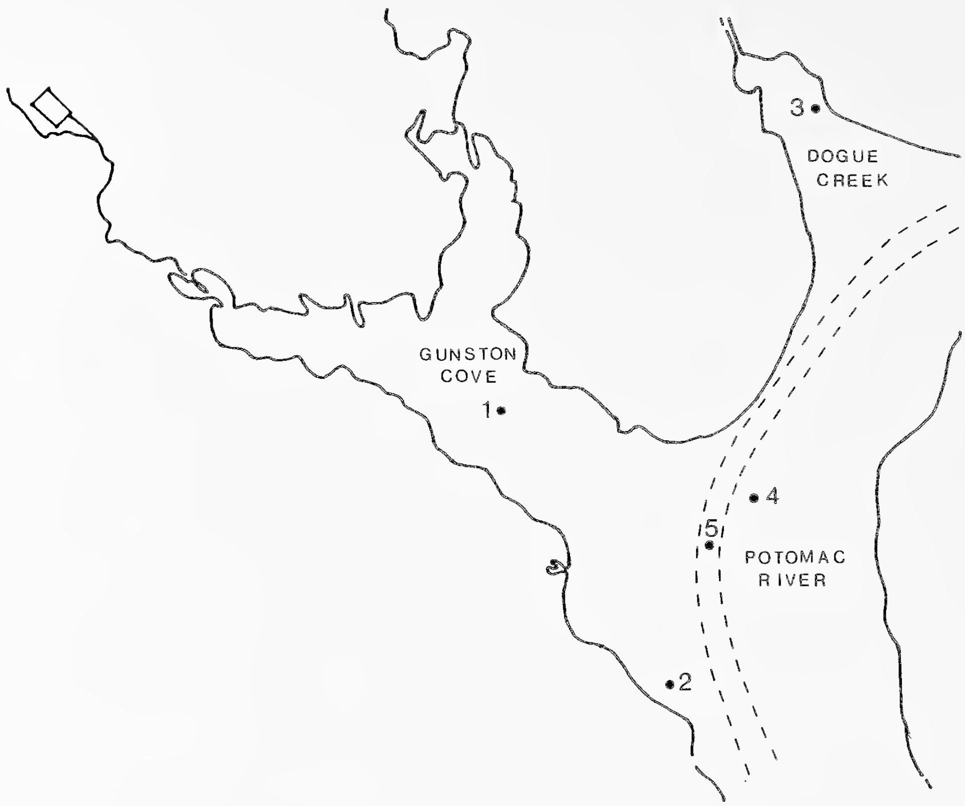


Figure 1. Study sites in the Potomac River estuary in Fairfax County, Virginia.

Prevalence of Parasitism

Encysted glochidia were found on 18 (14.3%) of the fish examined. Only two species, white perch, *Morone americana* (Percicthyidae) and spot, *Leiostomus xanthurus* (Sciaenidae), were parasitized. Both are new host records for natural glochidial infestations. Davenport and Warmuth (1965) exposed freshly excised pectoral and pelvic fins of white perch to glochidia of *Anodonta implicata* in an aquarium and observed glochidial attachment, but presented no quantitative data. This is the first record of either natural or experimental infestations of the spot, but a related species, the freshwater drum, *Aplodinotus grunniens*, is known to host at least 11 species of mussels (Fuller 1974).

Of 71 *M. americana* examined, 11 (15.5%) had encysted glochidia (Table 2). The numbers of infested *M. americana* were highest in early September (33%), declined through mid-September (17%), with no parasitized *M. americana* collected at the five study sites in October. However, in mid-November the prevalence of parasitism increased to 25%. Standard body lengths of infested *M. americana* ranged from 7.4 to 10.1 cm (mean, 8.45).

Of 13 *L. xanthurus* examined, seven (53.8%) contained encysted glochidia. Parasitism was more prevalent in spot than in white perch, with 67% parasitized in early September and 50% in mid-October. No spot were captured in November. The high percentages of parasitized individuals based on such small sample sizes suggest that this fish may be an important host

species in the study area. Standard body lengths of infested spot ranged from 7.9 to 10.0 cm (mean, 8.60).

Table 1. Prevalence of parasitism by glochidia of the Unionidae in fishes in the Potomac River watershed of Fairfax County, Virginia, 1988.

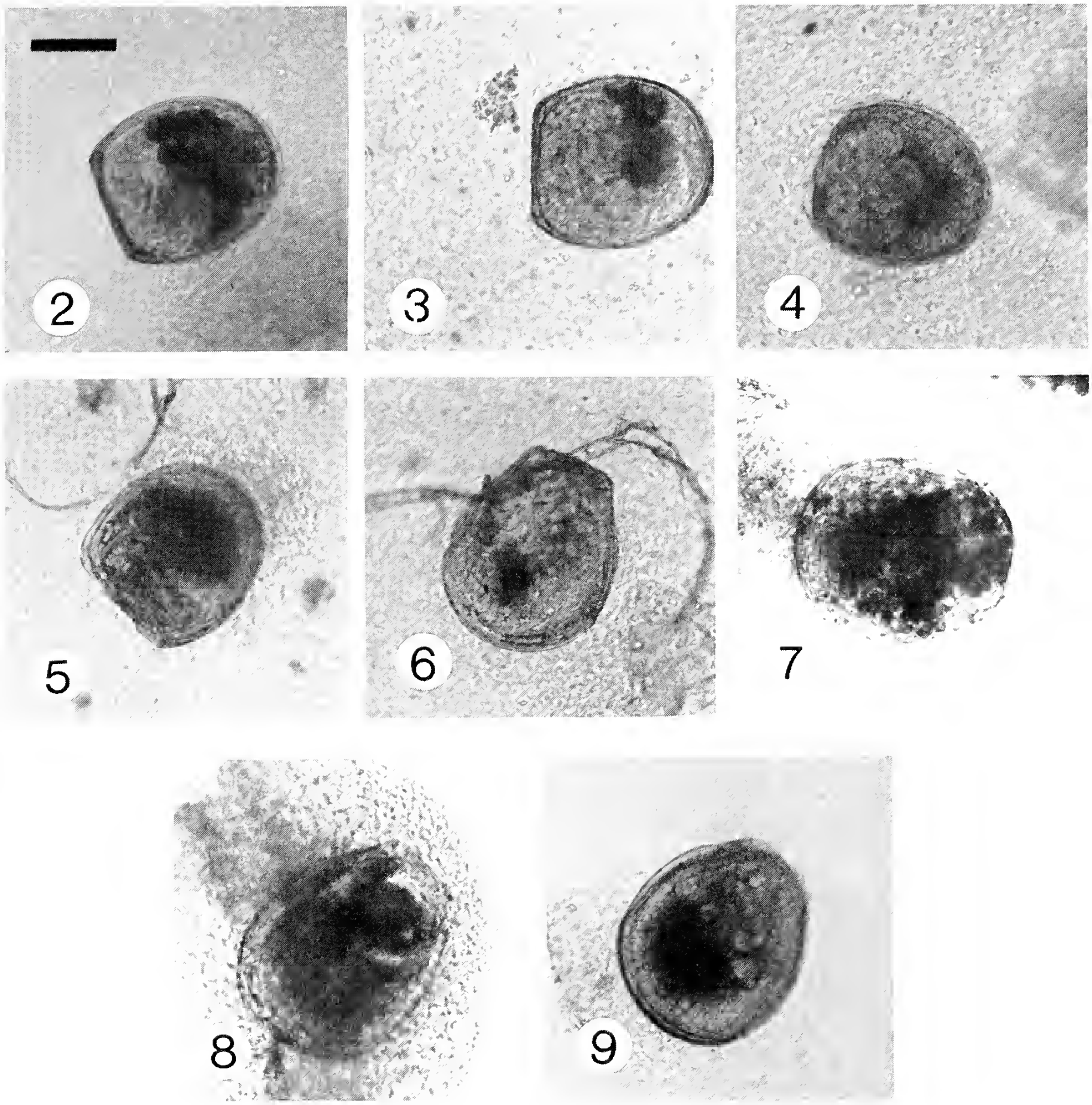
Fish species examined	Number	Number parasitized (%)
Atherinidae:		
Menidia beryliana	1	0
Centrarchidae:		
Lepomis gibbosus	1	0
Lepomis macrochirus	8	0
Clupeidae:		
Alosa pseudoharengus	10	0
Dorosoma cepedianum	11	0
Cyprinidae:		
Notropis sp.	1	0
Semotilus sp.	1	0
Semotilus corporalis	4	0
Engraulidae:		
Anchoa mitchelli	1	0
Percidae:		
Etheostoma flabellare	3	0
Etheostoma olmstedi	1	0
Percichthyidae:		
Morone americana	71	11(15.5)
Sciaenidae:		
Leiostomus xanthurus	13	7(53.8)
TOTALS	126	18(14.3)

The average numbers of encysted glochidia per fish were generally low, six (1-28) for *M. americana* and 11 (1-54) for *L. xanthurus*. With the exceptions of three glochidia encysted on gill rakers and one on a dorsal fin, all glochidia were located on the gill filaments. All glochidia examined under the compound microscope appeared to be hookless species of the subfamilies Lampsilinae and Ambleminae, some of which are probably species of *Elliptio* (See figures 2-9).

Table 2. Prevalence and intensity of parasitism of *Morone americana* and *Leiostomus xanthurus* by glochidia of the Unionidae in the Potomac River estuary, Fairfax County, Virginia, 1988.*

Locality	Collection Date 9/2	9/19	10/19	11/16
Morone americana				
Gunston Cove (site 1)	1/8(13) 1	-	0/6(0)	0/8(0)
Gunston Cove (site 2)	-	0/1(0)	0/11(0)	4/4(100) 3,5,6,2
Dogue Creek (site 3)	-+	-	-	0/2(0)
Potomac River (site 4)	2/4(50) 2,14	1/5(20) 3	0/11(0) 1	1/7(14)
Potomac River (site 5)	2/3(67) 1,3	-	-	-
TOTALS	5/15(33)	1/6(17)	0/28(0)	5/21(24)
Leiostomus xanthurus				
Gunston Cove (site 1)	-	-	-	-
Gunston Cove (site 2)	-	-	3/5(60) 1,2,3	-
Dogue Creek (site 3)	-	-	-	-
Potomac River (site 4)	-	1/2(50) 11	1/3(33) 2	-
Potomac River (site 5)	2/3(67) 6,54	-	-	-
TOTALS	2/3(67)	1/2(50)	4/8(50)	-

*Number of fish parasitized/number examined (% prevalence)
numbers of encysted glochidia per fish
+No fish examined.



Figures 2-9. Glochidia from naturally infested *Morone americana* and *Leiostomus xanthurus*. 2. Ambleminae from *Morone americana*. 3-5. Ambleminae from *Leiostomus xanthurus*. 6-8. Lampsilinae from *Morone americana*. 9. Lampsilinae from *Leiostomus xanthurus*. Bar equals 100 um. The spot, *L. xanthurus*, identified in this study, consumes mollusks, as well as crustaceans, annelids, fish, and vegetable debris. The white perch, *M. americana*, preys on fish and small invertebrates.

Discussion

The prevalence of glochidial infestations may vary by species, locality, season, abundance of mussels, or source of fish (Lefevre and Curtis 1910, Surber 1913, Stern and Felder 1978, Zale and Neves 1982b, Threlfall 1986, Neves and Widlak 1988). While the intensity of infestation is generally low (1-20 glochidia per fish), like those found in this study, certain fish species are

naturally parasitized by large numbers of glochidia. The drum, *Aplodinotus grunniens*, and the herring, *Alosa chrysochoris*, have been found with thousands of glochidia attached (Surber 1913, Howard 1914). Trdan (in Kat 1984) suggests that such great infestations may result from high levels of host specificity, necessitating concentration of glochidia on the available hosts. Factors such as the relative densities of mussel and host fishes and the levels of host immunity should also be considered as contributing to the rate of infestation (Stern and Felder 1978, Kat 1984).

The mean number of known host species per unionacean species is approximately four (Fuller 1974). Some mussels have only one known host, although there are probably other hosts which have not yet been identified. In contrast, *Anodonta grandis* has over 30 known host species. If host requirements are very specific, the loss of a single host species could have devastating effects on a mussel population. However, mussel species that utilize a variety of hosts have a greater probability of persistence.

Mechanisms which might reduce competition for available hosts are the concurrent use of different areas of the same fish (i.e. fins versus gills), and the parasitism of the same fish host but at different times of the year (Stern and Felder 1978).

The North American unionaceans exhibit a variety of adaptations which may increase the probability of contact with the correct host. One such mechanism is the timing of reproduction and glochidial release to correspond with periods of high host density and/or predictable host behaviors (Kat 1984).

One of the best-documented studies of the synchronization of glochidial release with a specific host behavior is that of *Anodonta implicata* and its anadromous host, the alewife (*Alosa pseudoharengus*). Even though the alewife spends only a short period of time in fresh water, the reproductive and developmental cycles of *A. implicata* are so well synchronized with the spawning run that they can infest, metamorphose, and drop off the alewife before it leaves the freshwater habitat (Davenport and Warmuth 1965).

Another adaptation which increases the probability of contact with the correct host species is mimicry of food items of the host. Glochidial conglutinates may resemble worms, leeches, or grubs (Chamberlain 1934, Kat 1984). Females of certain species of lampsiline have modifications of the mantle flap below the incurrent siphon which act as fish lures; the flaps resemble small, swimming fish with conspicuous eyespots and elaborate tails, and may attract piscivorous species.

The drum and catfish are molluscivorous, and may become heavily infected when they feed on gravid females. The drum, *Aplodinotus grunniens*, is a host to glochidia of at least 11 species of unionaceans (Fuller 1974). However, molluscivorous fish of the family Centrarchidae, such as the pumpkinseed (*Lepomis gibbosus*), are only known to host two species, while the largely vegetarian and insectivorous bluegill (*Lepomis macrochirus*) and green sunfish (*Lepomis cyanellus*) of the same family are host to 13 and 12 species, respectively. The five most commonly parasitized fish are omnivorous, insectivorous, and piscivorous (Kat 1984). The spot, *L. xanthurus*, identified in this study, consumes mollusks, as well as crustaceans, annelids, fish, and vegetable debris. The white perch, *M. americana*, preys on fish and small invertebrates.

Many species of freshwater fish have predictable cycles of migration and behavior. These may include movement from deep to shallow water in lakes, spawning migrations during the spring, aggregational behavior during reproductive cycles, and the movement of anadromous hosts such as the salmon into freshwater (Kat 1984). The release of glochidia by many short-term breeders (Ambleminae) corresponds with nesting behavior of the host. Hosts may construct nests in sandy patches within the mussel community, making the fish and its offspring susceptible to parasitism. The displacement of sediment with the fins during nest construction and maintenance may also promote attachment of glochidia lying on the sediment surface (Kat 1984).

The bottom-dwelling activities of darters and the nest-building behavior of centrarchids have been implicated in high rates and intensity of parasitism for these two groups in Michigan (Trdan and Hoeh 1982). The "lurking" predation strategy of pike, whose stomach contents may contain appreciable numbers of glochidia during natural feeding, may also provide opportunities for glochidial attack (Dartnall and Walkey 1979).

Acknowledgments

I thank Dr. Donald P. Kelso, George Mason University, for providing the specimens of fish and for his advice during this study, and Dr. Richard Neves, Virginia Polytechnic Institution and State University, for help with identifications of glochidia.

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A New Coastal Plain Location for Several of Maryland's Ferns

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An outcropping of fossil-bearing marine marls on the Chester River in Kent County has produced several interesting fern records. While similar outcroppings are located on both the Kent and Queen Anne's County sides of the river, the unique aspect and protected surroundings of this location have proven conducive to the establishment of populations of several ferns commonly associated with limestone outcroppings in more western parts of the state. The following information will add to the body of knowledge on the distribution, dissemination, and ecology of these fern species.

This outcrop is located approximately 2.4 miles SSE of Chestertown, on a north-facing bluff overlooking the Chester River. The marl exposure is up to thirty feet high, nearly vertical, and extends for approximately 200 feet along the river. Massive chunks of marl containing numerous fossil shells have broken away from the face of the bluff and become lodged on the sand at the water's edge, forming a protective bulwark against tidal action. A mature chestnut oak (*Quercus prinus* L.) forest grows atop the bluff, providing shade throughout the summer months. Weathering of the fossil shell deposits has coated many areas of the bluff face with a white layer of calcium carbonate. The abundant calcium carbonate produces local geochemical conditions similar to those more typical of limestone outcrops.

The most abundant pteridophyte growing on the face of the bluff is the purple cliff-break (*Pellaea* x *atropurpurea* [L.] Link). This cliff loving fern is found primarily in drier, more exposed areas where fossil shell beds outcrop, although scattered individuals occur sporadically across the face of the bluff. All previous records of this species in Maryland were from areas west of the Fall line (Redman 1991, Reed 1953), which separates the Coastal Plain from the Piedmont Province, and this is the first report of purple cliff-break from the Maryland Coastal Plain. Most previously known Maryland localities were from calcareous rocks, although it has occasionally been found on non-calcareous substrates (Reed 1953). Lellinger (1985) described the purple cliffbreak as "Epipetric in crevices in calcareous cliffs and rock ledges, on limestone walls, in limey mortar on walls, or rarely terrestrial".

Second in abundance at this site is the walking fern (*Asplenium rhizophyllum*). A large population is present, densely clustered across the face of the bluff, from the top to the bottom, covering an area of approximately 600 square feet. This fern also occurs in crevices of the large fallen blocks of fossiliferous marl that lay at the water's edge. Growing with typical *A. rhizophyllum* at this site is the interesting "eared" form of this fern that has been called forma "auriculatus". These two variants grow together and they appear to be evenly distributed. As with *P.* x *atropurpure*a, all previous, recent records for this species in Maryland have been on rock outcrops west of the Fall Line (Redman 1991, Reed 1953). However, it is interesting to note that Brown et al. (1987) documented several collections of this species from the Maryland Coastal Plain prior to 1753. Lellinger (1985) described the walking fern as "Epipetric on usually limestone rocks and ledges, occasionally epiphytic or on fallen tree trunks".

Scattered infrequently throughout this exposure are fronds of Scott's spleenwort (*Asplenium* x *ebenoides* R.R. Scott). This fern, which is a sterile hybrid of the walking fern and the ebony spleenwort (*Asplenium platyneuron* [L.] B.S.B.), has been reported from limestone at several localities west of the Fall Line (Redman 1991, Reed 1953), and is one of our rarer ferns. Lellinger (1985) described this fern as "Epipetric on sandstone, conglomerate, and limestone cliffs". Both *A. rhizophyllum* and *A. platyneuron* occur together with *A.* x *ebenoides* at this site.

Another interesting fern found in abundance at this site is the resurrection fern or gray polypody (*Polypodium polypodioides* var. *michauxianum* Weath.). This fern occurs on the trunks of chestnut oaks growing horizontally across the top of the face of the bluff. Prior records for resurrection fern in Maryland include several sites on the lower eastern shore (Redman 1991, Reed 1953), and an introduced population along the Potomac River below Great Falls in Montgomery County (Reed 1953).

Specimens of each of these species have been deposited in the Reed Herbarium, Darlington, Maryland, and the herbarium of the Maryland Natural Heritage Program, Maryland Department of Natural Resources, Annapolis, Maryland.

Dr. Clyde Reed visited this site with me and confirmed my identifications for the species discussed above.

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A Variant Specimen of the Northern Copperhead, *Agkistrodon contortrix mokasen*, from Southern Maryland

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On August 16, 1986 an unusual specimen of the northern copperhead (*Agkistrodon contortrix mokasen*) was captured near Pine Hill Run on the Patuxent River Naval Air Station in southern St. Mary's County, Maryland. The snake was an adult, sex unknown, and measured approximately two feet in length. It was captured alive and kept in captivity at the Environmental Education Center on the Naval Air Station.

The unusual feature of this snake is its anomalous dorsal color pattern. Background and marking colors are normal, but the shapes of the markings are quite unusual. Typically, the dorsum of this species contains dark markings on a light background. Kelly (1936) described it's pattern as a series of chocolate-brown blotches (usually eighteen) across the stout body, beginning a short distance from the head and continuing the entire length. Viewed from above, they appear hourglass in shape; laterally, like an inverted "Y". Conant (1975) described dark chestnut crossbands which, when viewed from above, are wide on the sides and narrow at the center of the back. He indicated that small dark spots are frequently present between crossbands, as well as dark rounded spots at the sides of the belly. Wright and Wright (1957) described typical specimens as having a pattern of broad, dark crossbands variously described as "spool-shaped" or "dumb-bell-shaped", constricted middorsally and rounded off at the ends above the ventrals. They also noted that specimens from some localities are occasionally marked with small round or irregular spots between the crossbands. McCauley (1945) described local specimens as having from sixteen to 21 (average nineteen) dark, transverse saddles that are narrow dorsally but broaden on the sides. He noted that the saddles did not always meet evenly on the mid-dorsal line.

The individual collected on the Naval Air Station has a very strong pattern of dark circular markings or blotches on the dorsal surface (Figure 1). Of the eighteen dark bands on this snake, only eleven are complete and none demonstrate the distinctive saddle shape that is so characteristic of this species. Four of the dark bands do not meet at mid-dorsum, and three meet only at their corners. Every light-colored interspace between the dark bands contains at least one dark circular marking. Most interspaces contain two of these spots, one on each side of the mid-dorsum. The eighth, ninth, tenth, and eleventh interspaces each have four spots, and the seventh interspace has five. The size of these spots varies from four to fourteen millimeters in diameter. The largest spots occur near the center of the body, with spot size decreasing as the body diameter decreases toward both head and tail. The tail is dark for over half its length. Ventral markings and coloration are typical.

Unfortunately, the snake died in captivity of unknown causes, but has been preserved for further study.

Figure 1. Anomalous dorsal color pattern of variant specimen of northern copperhead from southern Maryland.

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Biodiversity of Robber Flies (Diptera: Asilidae) in Maryland and Delaware: Part I. Subfamily Leptogastrinae

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Introduction

Members of the family Asilidae are conspicuous elements of the dipterous faunas of the world, numbering more than 5000 species world wide, with approximately 1000 in America north of Mexico. Adults are easily recognized by the deep sunken vertex, the more or less bearded face, a stout thorax and long, strong bristly legs. Most of them have a long tapered abdomen, but some are stout-bodied, with abundant vestiture, and resemble bumblebees. Still others are very slender, appearing somewhat like miniature damselflies. They range in body length from 4 to over 50 mm. Adults occur in a wide variety of habitats, such as grassy fields, pine barrens, forests, sandy fields, beaches, etc., although some species are limited to more specific habitats.

The total number of Maryland species is unknown. The catalog of Diptera (Stone et al. 1965) includes 114 species that are probable Maryland residents. More locally, McAtee and Banks (1920) listed 83 species from the Washington, D. C. area, and Scarbrough (1974) reported 40 species from three locations in Baltimore County, Maryland. Shelly (1979) listed 84 species from Pennsylvania, several of which probably exist in Maryland. A search of museum and private collections indicates that the asilid fauna of Maryland is greater than expected. Only one thorough study has been conducted for an eastern state, i.e. Connecticut (Bromley 1946), although checklists of species exist for Georgia (Fattig 1945), Florida (Bromley 1950) and Pennsylvania (Shelly 1979).

The purpose of this research is to assess and report the biodiversity of Maryland species of asilids, provide keys and illustrations for their identification, notes on the seasonal and geographical distribution of the species, and general ecological and biological data. This paper reports the subfamily Leptogastrinae. The other subfamilies of Asilidae occurring in Maryland and Delaware (Asilinae, Dasypogoninae, and Laphriinae) will be treated separately.

Biology of Maryland Asilidae

Adults of some species are often locally abundant. Estimates of populations of *Eudioctria tibialis* (Banks) (Scarbrough 1981a), *Cerotainia albipilosa* Curran (Scarbrough and Norden 1977) and *Holcocephala abdominalis* (Say) (Scarbrough 1982, unpublished data) from specific localities in central Maryland typically yield 100 or more specimens. Other species are far less abundant, and may be found only occasionally in a season (Scarbrough 1974).

Because of their predaceous habit of feeding on insects, and voracious appetite, they contribute to the natural control of insect populations. Recent studies (Hespenheide 1978; Hespenheide & Rubke 1977; Lavigne & Holland 1969; Scarbrough 1978b, 1981b; Scarbrough and Sipes 1973; Scarbrough and Sraver 1979; Shelly 1979) suggest that they are opportunistic

predators, feeding on a wide array of insects, including wasps, bees, grasshoppers, termites, beetles, and other flies. Prey selection is directly related to the body size of the predator and prey, and the relative abundance of prey. Though one fly may chase a prey of a greater size than itself and even attempt to impale it upon its beak, prey items are usually smaller than the predators. Selection of prey species fluctuates with increased densities in some species. Relative numbers of specific prey in the diets of *Eudoctria*, *Atomosia* and *Cerotainia* usually change significantly as prey densities increase (Scarbrough 1978b, 1981b, 1982), i.e. when swarms of termites or ants are available.

General feeding rates of adults have been estimated for only a few species. Both *Holcocephala abdominalis* and *H. calva* (Loew) were found to feed on an average of 2 prey items per hour per day in the shadow of a tree lined stream (linear distance approximately 350 m), and were active for about 11 hours per day in August (Scarbrough 1982). Thus, two hundred adults could eliminate 4,400 insects per day.

Little is known of the biology of immature stages. The developmental stages of asilids in general are spent in decaying wood or soil, feeding on arthropods inhabiting these sites. Some species feed on agricultural pests, i.e. white grubs (Coleoptera, *Phyllophaga* spp). Of the Maryland fauna, pupal cases of only three species of *Machimus* Loew have been described, and their developmental habitats determined (Scarbrough and Kuhar in press). Much more is known of the biology of adult asilids. Scarbrough (1978a, 1978b, 1981a, 1981b, 1982), Scarbrough and Norden (1977), Scarbrough and Sipes (1973), and Scarbrough and Sraver (1979) have reported the seasonal distribution, diurnal activity period, mating and predatory behavior of several species.

Importance of Biodiversity Studies

Maryland, like many east coast states, is experiencing rapid changes in its natural environments. Natural ecosystems are being modified, reduced in size, or eliminated entirely by expanding urbanization, industrialization and the creation of recreation facilities. All impact directly on our natural biota. Some asilids become reduced in numbers and are only occasionally found, while others disappear altogether from disturbed areas.

Not surprisingly, much of the natural biota of Maryland is poorly known, and biological data concerning most known species are either outdated or non-existent. Often, rare or uncommon species become endangered or are lost locally before basic biological information is accumulated on them. Consequently, we are in a race with time to catalogue and determine the relative abundance of our natural fauna. We desperately need a better understanding of our animal and plant populations, and the degree to which environmental perturbation influences our native species. This is particularly important to such areas of research as rare and endangered species management, pest management, biogeography, and regulation of exotic pest species.

From a practical point of view, many native species play important roles in the regulation and control of pest species while others may serve as biological indicators of environmental quality. Because we import large quantities of materials and animal and plant products from foreign lands, our state often serves as a port of entry for the establishment of non-endemic

species. Exotic species are often highly adaptable to new environments, and natural control agents for such species are invariably absent in this country. With unrestricted population growth, introduced species are potential or realized medical or economic pests, i.e. the tiger mosquito and gypsy moth, respectively. Thus, it is important to establish a system for monitoring our insect populations. Such a system would provide a basis for determining environmental quality and for early detection of invading species.

Asilids, like many other insects, are short lived and usually remain in close proximity to their breeding sites. Populations of such animals are thus readily influenced by environmental disturbance of such sites, often experiencing localized or even regional extirpation when habitats are destroyed. The greatest abundance and diversity of species is usually correlated with undisturbed natural habitats, whereas disturbed habitats are correlated with reduced abundance and diversity. Urbanized communities and recreational lands yield few specimens or species. Thus, asilid abundance and diversity may be useful in assessing the relative severity of environmental disturbance and degradation.

Methods

Collections of Maryland and Delaware asilids from the following sources were examined through the courtesy of their respective curators: Salisbury State University (William Grogan), Towson State University (AGS), University of Delaware (Douglas Tallamy), Maryland Department of Agriculture (Charles Staines), Natural History Society of Maryland (Arnold Norden), United States National Museum (Wayne Mathis and Christian Thompson), The State University of New Jersey at Rutgers (Michael L. May), and Philadelphia Academy of Sciences (Donald Azuma). Additional records of Maryland species, and pertinent biological data were obtained through a literature search, and are included in the species accounts.

The taxonomic synopsis presented in this paper consists of information regarding the original citation and author for each species. Type locality and type repository were obtained from the literature and museums. Seasonal distribution is expressed as range of earliest and latest known collection dates for Maryland specimens. Keys to subfamilies, genera and species were modified from existing literature. Entomological terms follow McAlpine (1981). Illustrations of relevant characters were made from museum specimens. An explanation of abbreviations found in figures of male genitalia (Figures 8-19) is given in the captions for Figures 8 and 10.

Part I: Subfamily Leptogastrinae

Members of this subfamily are small to medium flies with long, unusually slender abdomens. These elongate flies inhabit grassy areas and herbage and bushy undergrowth within forests in Maryland and elsewhere. They, like members of the other subfamilies of the Asilidae, are characterized by their predaceous habits and slender stylate mouth parts which are adapted to penetrate and suck fluids from the bodies of arthropod prey. The absence of an alula (wing narrowly constricted), pulvilli (claws), acanthophorites (female terminalia), and larval mandibles distinguish them as a group (Artigas and Papavero 1988). Their slender bodies and unique behavior, such as the capture of resting prey, hovering flight, aerial oviposition, and association with grasses are also important synapomorphic characters which separate them from other asilid groups.

Biology

Little biological information is available for species within this subfamily. Adults feed primarily on small, soft bodied arthropods, especially species of the insect orders Orthoptera, Diptera (Fig. 1), and Homoptera-Hemiptera, and small spiders (Bromley 1946, Melin 1923, Newkirk 1963, Scarbrough and Sipes 1973). These flies capture flying prey during "roving or searching" flights, or by short "darting" flights while prey are resting on plants. They feed while holding onto the edge of a leaf or stem by their forelegs. Prey are usually rotated one to two times while feeding, with the proboscis being inserted in a different location each time. Prey carcasses are usually released at the feeding site. Newkirk (1963) and Scarbrough and Sipes (1973) described the foraging and feeding habits of *Psilonyx (=Leptogaster) annulatus* (Say) and *Leptogaster flavipes* Loew, respectively.

Figure 1. *Leptogaster flavipes* Loew with prey, *Drosophila melanogaster* L.

Figure 2. A mating pair of *Leptogaster flavipes* Loew, with the male suspended below the female in a tail-to-tail position.

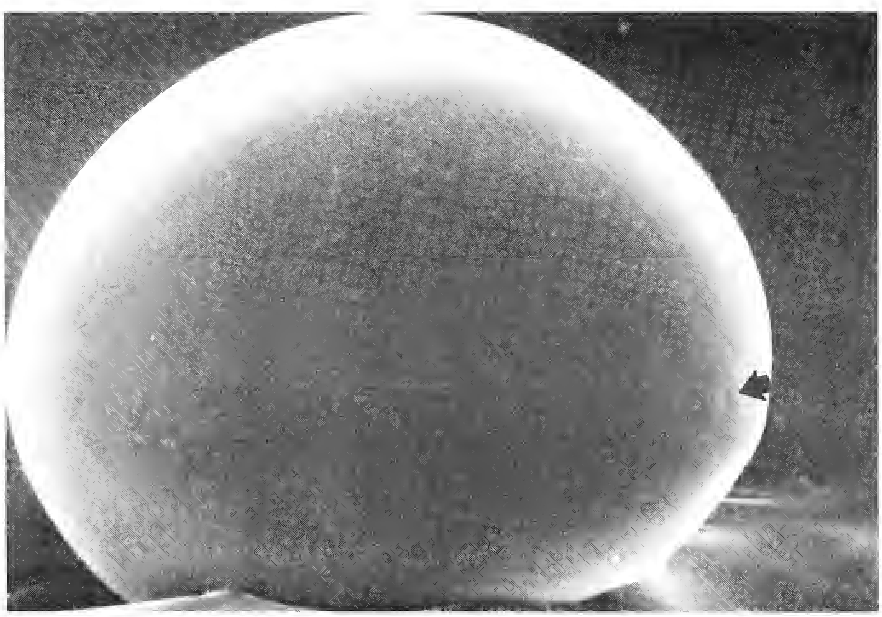

Figure 3. SEM photograph of an egg of *Psilonyx annulatus* (Say), showing the smooth chorion and micropyles (sperm pores, see arrow).

Sexual selection of mates is apparently simple, and occurs at random. Males of *L. cylindrica* DeGeer, *L. flavipes* and *Psilonyx annulatus* mount flying or resting females without any discernable prenuptial behavior, quickly grasping the female genitalia ventrally and assuming a heads-down position (Fig. 2). Females hang by the forelegs from leaves or slender stems when mating. Following mating, females drop eggs singly in flight or below perch sites. Eggs are small, less than a millimeter in length, and oval. The egg chorion of *L. flavipes*, *Psilonyx annulatus* (Fig. 3), *Tipulogaster glabrata* (Wied.), and *Beameromyia pictipes* (Loew) is smooth and dark amber to yellow in color. Larvae of *L. flavipes* emerge from eggs 10-14 days following oviposition (Scarbrough & Sipes 1973). In the few instances where larvae and pupae are known, they are found in soil, and presumably require at least one year for developing to the adult stage (Malloch 1917, Melin 1923). Larvae probably feed upon other small soil arthropods.

Systematic Treatment

Meigen (1803) first proposed the genus *Leptogaster* in his classification scheme to divide the Asilidae into five genera. Prior to 1910 all 17 North American species were placed in this genus, primarily through the work of Osten-Sacken and Loew (Back 1909). Later, the genera *Tipulogaster* Cockerell (Cockerell 1913) and *Psilonyx* Aldrich (Aldrich 1923) were separated from the New World *Leptogaster*. Martin (1957), in revising the North American species, proposed the genera *Beameromyia* and *Apachelokos*, and recognized 50 species within 6 genera. Recently Wood (1981) and Artigas & Papavero (1988) contributed new keys to the genera of the Nearctic faunas and the Americas, respectively.

Key to the subfamilies of Maryland and Delaware Asilidae
(Modified from Wood 1981)

1. R_{2+3} ending in costa, cell r_1 open at the wing margin (Figs.4a,b) 2

- R_2+$_3$ merging with R_1 before wing margin, cell r_1 closed before the wing margin, e. g. petiolate (Fig. 4c) 3

2. Abdomen unusually slender, segment 2 five or more times as long as wide; alula and pulvilli absent .... Leptogastrinae

- Abdomen broad, segment 2 less than five times as long as wide; alula and pulvilli present .... Dasypogoninae

3. Antennae without a terminal style .... Laphriinae

- Antennae with a long terminal style .... Asilinae

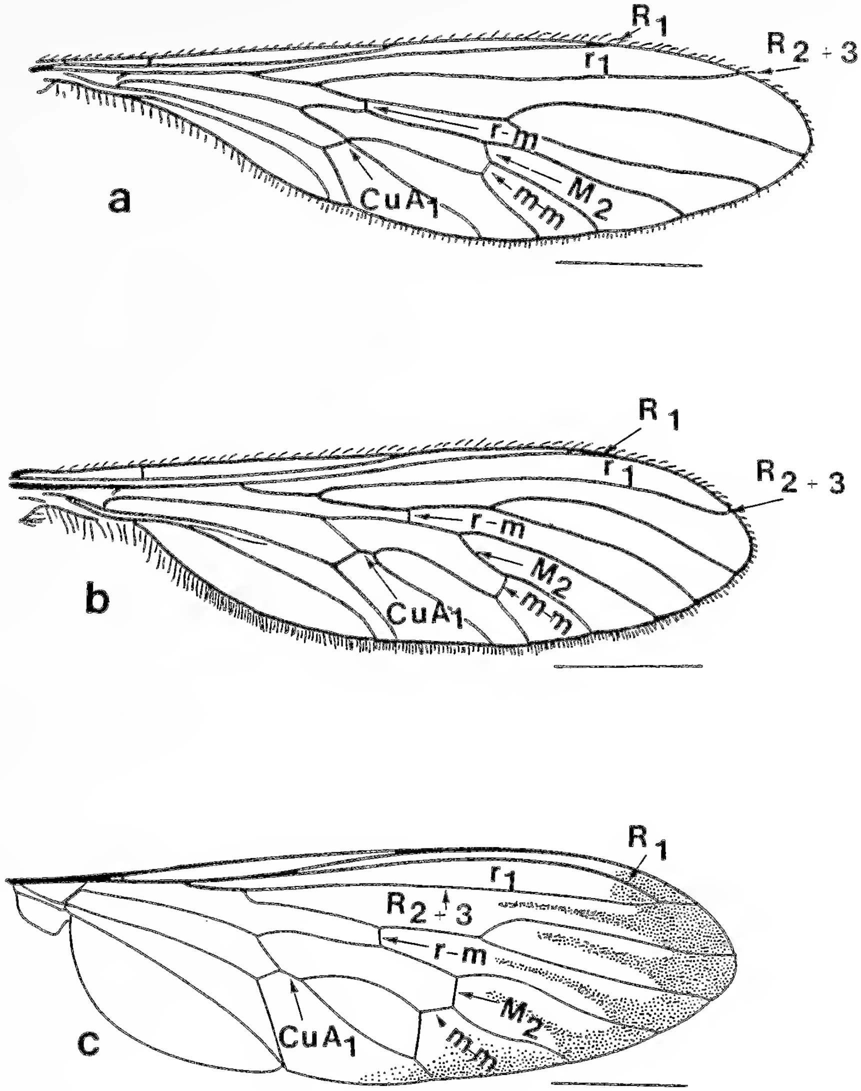

Figure 4. Wings of *Psilonyx annulatus* (Say) (a), *Leptogaster flavipes* Loew (b), and *Ommatius parvus* Bigot (c). Abbr.: R_1 = First radial vein, R_{2+3} = radial veins 2 and 3 fused, r_1 = first radial cell, r-m = radiomedial crossvein, M_2 =second medial vein, m-m = medial crossvein, CuA_1 = veins Cu & A_1 fused. Scale = 1.0 mm.

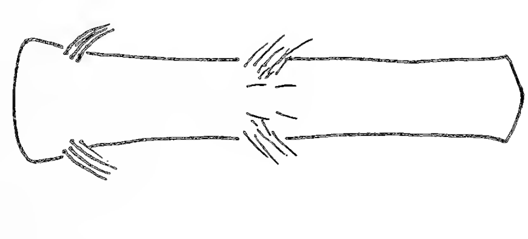

Figure 5. Tergite 2 of *Psilonyx annulatus* (Say) with a midlength band of fine setae. Scale = 1.0 mm.

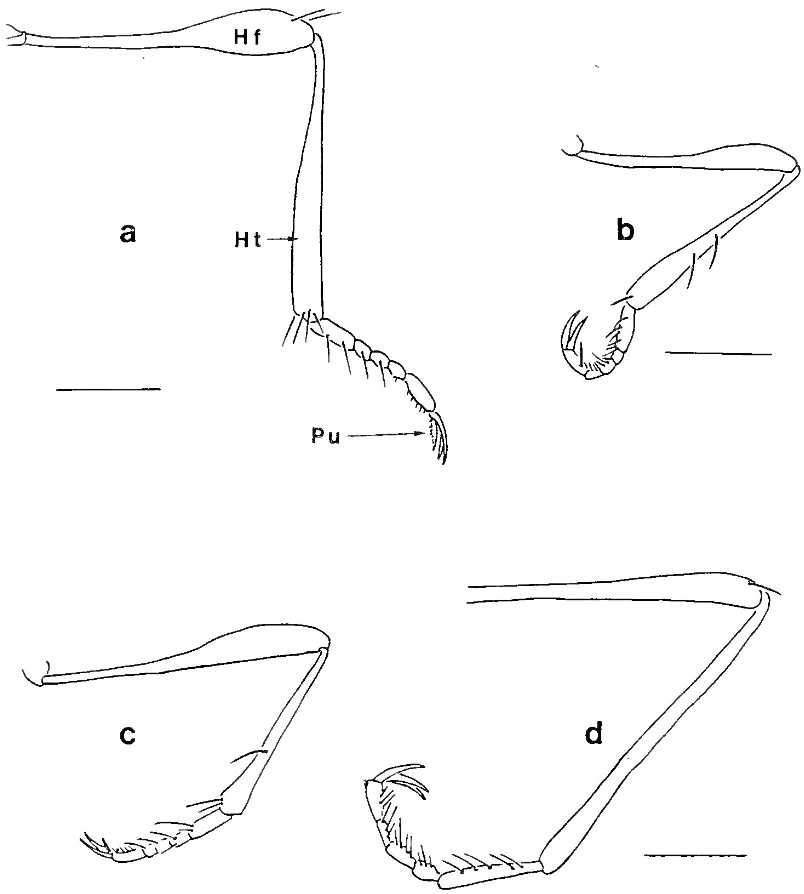

Figure 6. Hind legs of *Beameromyia vulgaris* Martin (a), *Psilonyx annulatus* (Say) (b), *Leptogaster flavipes* Loew (c), and *Tipulogaster glabrata* (Wied.) (d). Abbr.: Hf = hind femur, Ht = hind tibia, Pu = pulvillus. Scale = 1.0 mm.

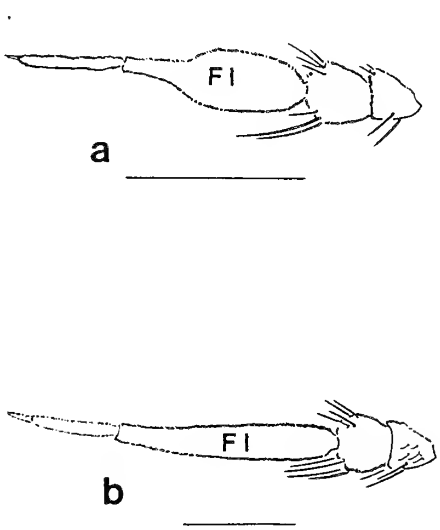

Figure 7. Antenna of *Leptogaster flavipes* Loew (a) and *Tipulogaster glabrata* (Wied.) (b). Abbr.: Fl = flagellum. Scale = 0.3 mm.

Key to the genera of Leptogastrinae Schiner of Maryland and Delaware
(Modified from Martin 1957 and Wood 1981)

1. Middle of second abdominal tergite with a transverse band of long pile (Fig. 5); base of M_2 short, less than 1.5 times length of crossvein m-m; crossvein m-cu short, or veins M_3 and CuA_1 narrowly fused, less than length of crossvein r-m (Fig. 4a) 2

- Middle of second abdominal tergite without a transverse band of pile; base of M_2 often long, two or more times length of crossvein m-m; crossvein m-cu absent; fusion of veins M_3 and CuA_1 longer than crossvein r-m (Fig. 4b) 3

2. Empodium present, hind tibia swollen on apical two-thirds (Fig. 6a); epandrium at most with a shallow notch; genitalia as in Figs. 10-12 .... *Beameromyia* Martin

- Empodium absent, hind tibia slightly swollen (Fig. 6b); epandrium with deep cleft, forming a narrow dorsal and a wide ventral lobe; male genitalia as in Figs. 8a-d; (8-12 mm) .... *Psilonyx annulatus* (Say)

3. Scutellum with short, stiff marginal bristles or setae, slightly more than half length of crossvein r-m; hind femora slightly swollen apically, beginning about apical half; epandrium divided to apical half or more, ventral lobe subequal in length and narrower than dorsal lobe; male genitalia as in Figs. 9a-d; female with sternite 9 notched apically; (4-7 mm) ..... *Apachekolos teniupes* (Loew)

- Scutellum without stiff marginal bristles or setae; hind femora strongly clavate on the apical one-third; genitalia not as above; sternite 9 of female without an apical notch 4

4. Flagellum wider, about one-fourth as wide as long; length not more than twice as long as the first two antennal segments combined (Fig. 7a); hind femora swollen apically (Fig. 6c); genitalia as in Figs. 14-19 .... *Leptogaster* Meigen

- Flagellum slender, about one-sixth as wide as long, 2.5 times as long as the first two antennal segments combined (Fig. 7b); hind femora slender (Fig. 6d); genitalia as in Figs. 10a-e; (12-15 mm)...*Tipulogaster glabrata* (Wiedemann)

Key to the species of *Beameromyia* Martin from Maryland and Delaware
(Modified from Martin 1957)

1. Occiput entirely gray pruniose; epandrium truncate apically; genitalia as in Figs. 11a-d; (5-7 mm) .... *pictipes* (Loew)

- Occiput dorsally, or at least posterior base of ocellar tubercle, brown pruniose; epandrium pointed apically, genitalia not as above 2

2. Ground color of apical bands of abdominal segments yellow or reddish yellow, with yellowish pollen; genitalia as in Figs. 12a-d; (5-7 mm) ... *vulgaris* Martin

- Ground color of abdominal segments dark red, segments 2-4 and apical corners of 5 white pruniose; genitalia as in Figs. 13a-d; (5-7 mm) ... *disfascia* Martin

Key to the species of *Leptogaster* Meigen from Maryland and Delaware
(Modified from Martin 1958)

1. Sternite 9 of male smooth, well defined grooves absent (Figs. 14c-15c) 2

- Sternite 9 of male with two parallel or convergent grooves, forming three distinct sections, the median one triangular or rectangular (Figs. 16c-19c) 3

2. Scutum entirely tomentose; epandrium with a deep cleft apically, genitalia as in Figs. 14a-d; length of empodium subequal to tarsal claws; (9-13mm) .... *virgata* Coquillett

- Scutum with three polished stripes; epandrium lacking a deep cleft, apex truncate, genitalia as in Figs. 15a-e; empodium short, about one-half length of tarsal claws; (10 mm)... *brevicornis* Loew

3. Scutum and abdominal segments 2-4 polished dorsally; genitalia as in Figs. 16a-e; (8-9 mm).. *atridorsalis* Back

- Scutum and abdomen entirely tomentose; genitalia not as above 4

4. Mystax with at most 10 bristles; narrow apex of hind tibia brown 5

- Mystax with 12 or more bristles; apical half of hind tibia brown, basal half yellow; genitalia as in Figs. 17a-f; (12-15 mm) .... *murina* Loew

5. Scutum entirely black; male epandrium narrow, pointed apically, genitalia as in Figs. 18a-f; (8-13 mm) .... *flavipes* Loew

- Scutum black dorsally, reddish laterally; male with wide epandrium, subtruncate apically; genitalia as in Figs. 19a-e; (10-13 mm) .... *incisuralis* Loew

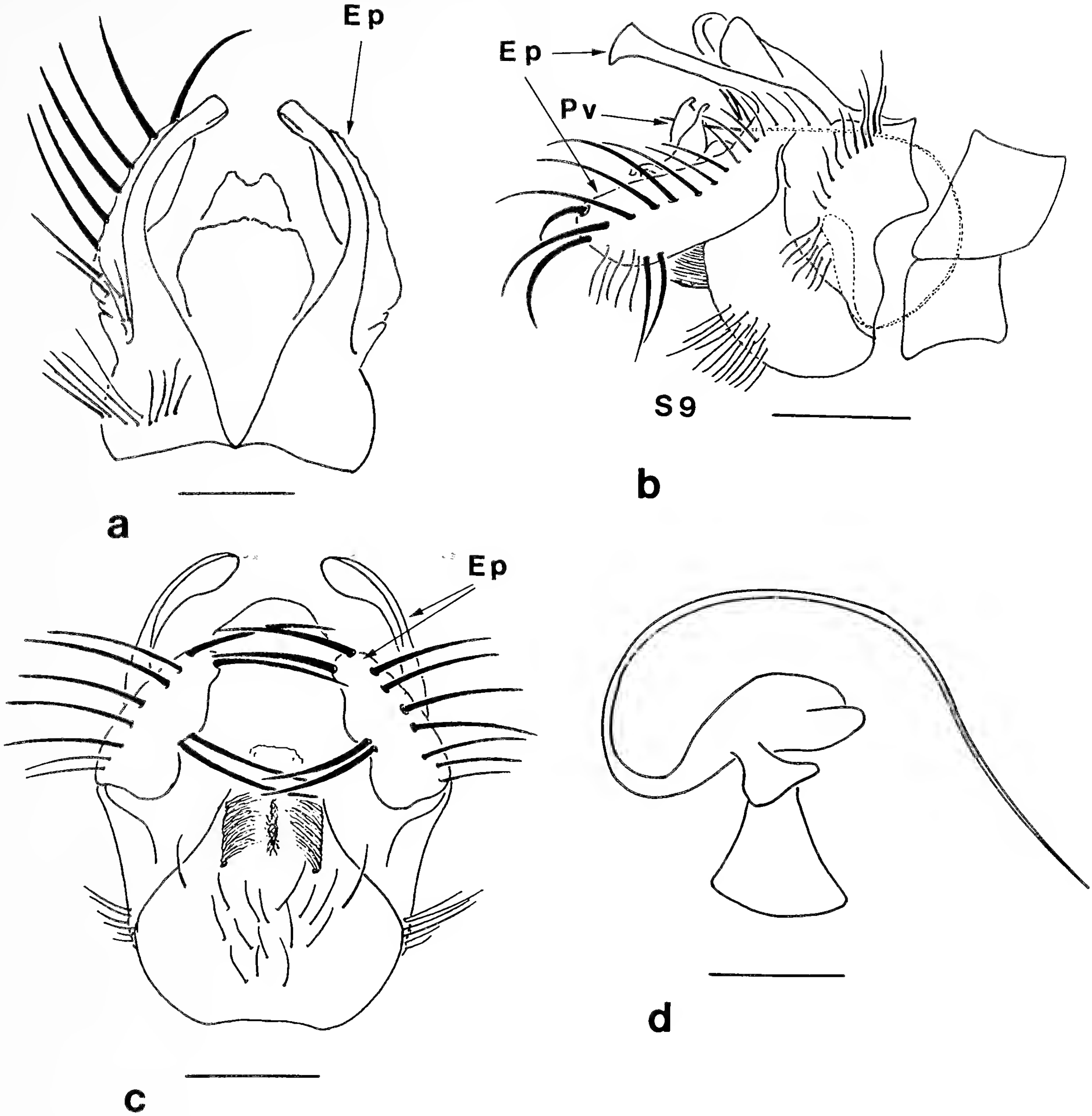

Figure 8. Male genitalia of *Psilonyx annulatus* (Say); dorsal (a), lateral (b), and ventral (c) views; aedeagus (d). Abbr.: Ep = epandrium, Pv = penal valves. Scale = 0.5 mm.

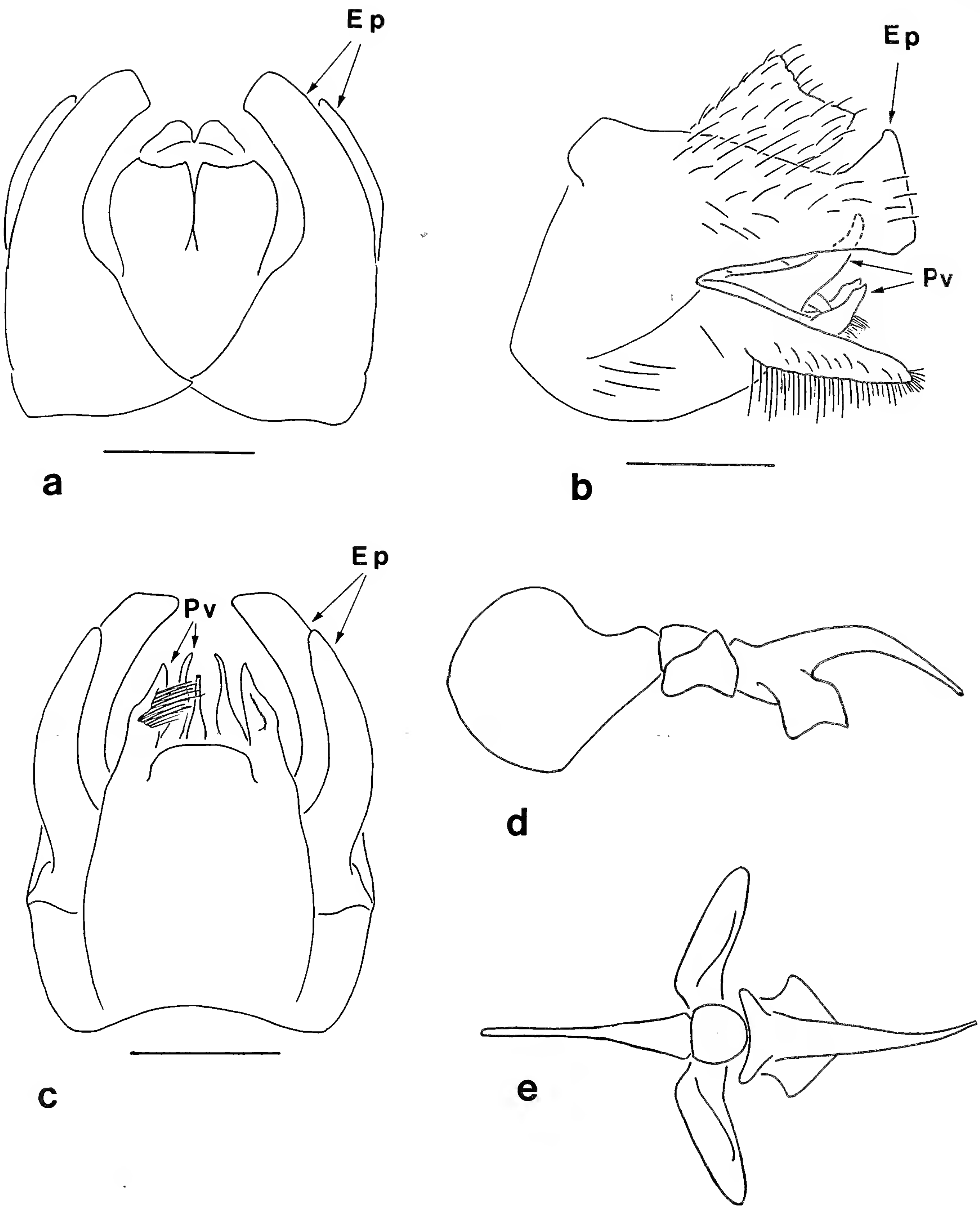

Figure 9. Male genitalia of *Apachekolos tenuipes* (Loew); dorsal (a), lateral (b), and ventral (c) views; aedeagus (d). Scale = 0.5 mm.

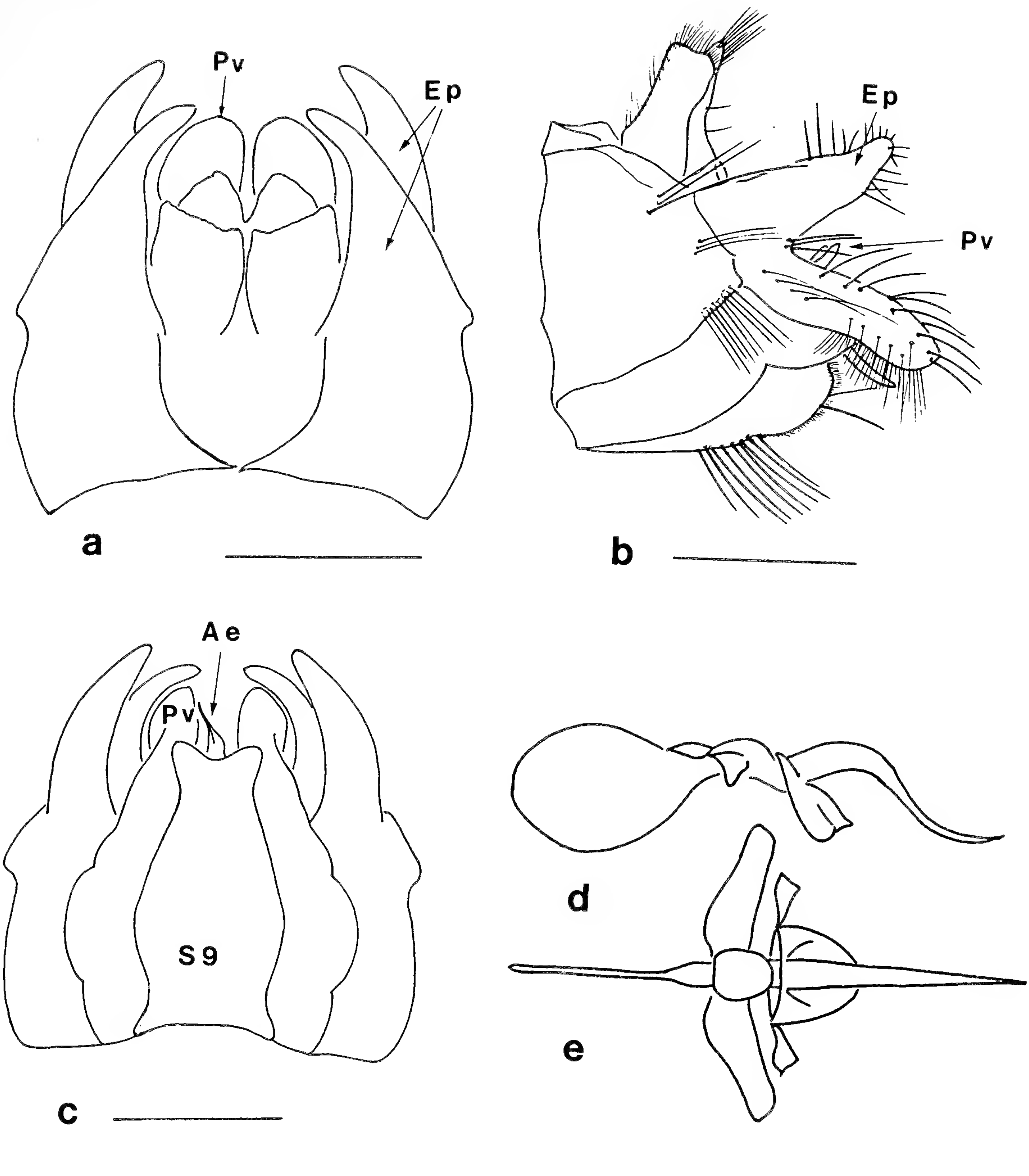

Figure 10. Male genitalia of *Tipulogaster glabrata* (Wied.); dorsal (a), lateral (b), and ventral (c); aedeagus (d). Abbr.: Ae = aedeagus, S9 = sternite 9. Scale = 0.5 mm.

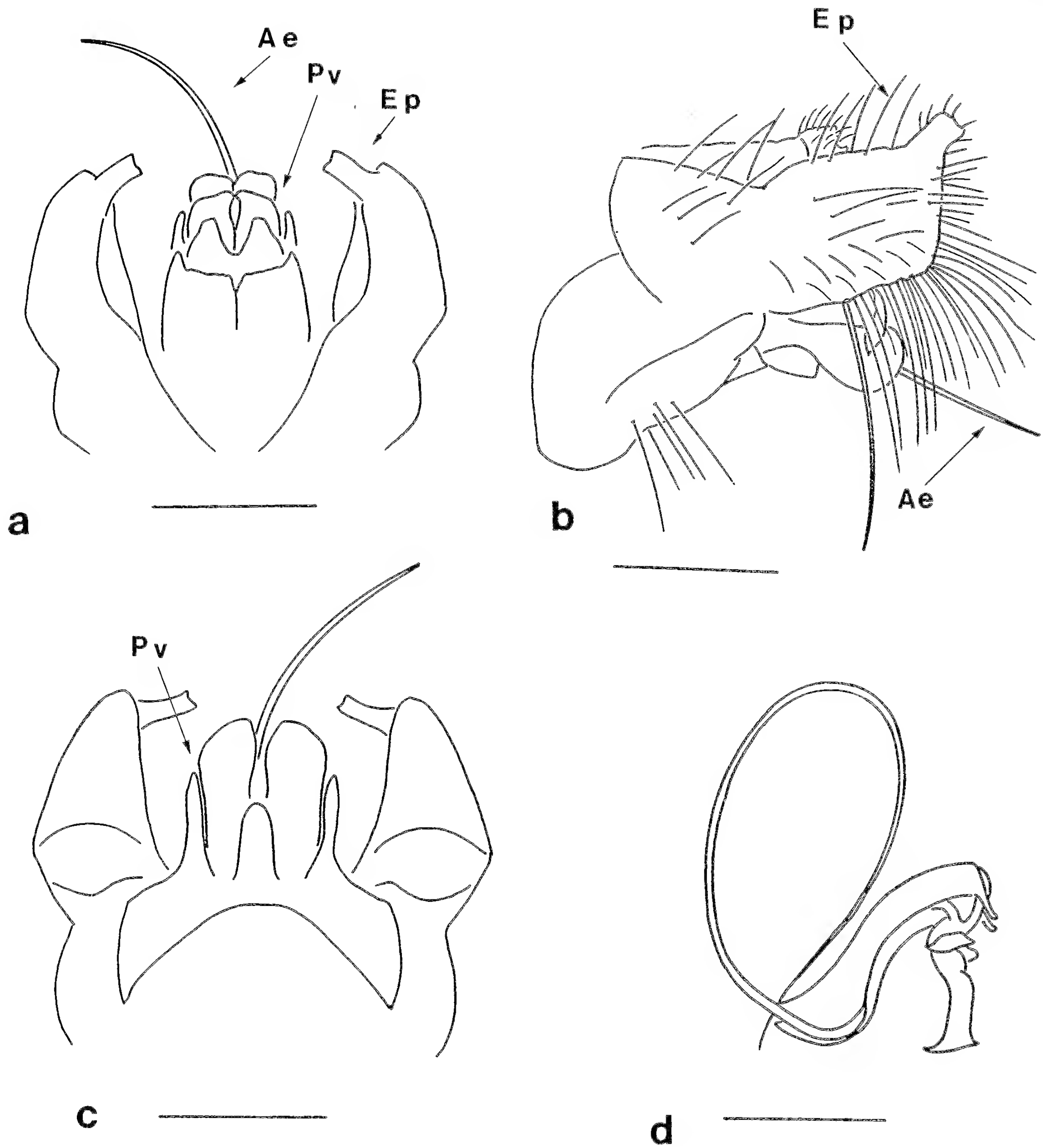

Figure 11. Male genitalia of *Beameromyia pictipes* (Loew); dorsal (a), lateral (b), and ventral (c) views; aedeagus (d). Scale = 0.3 mm.

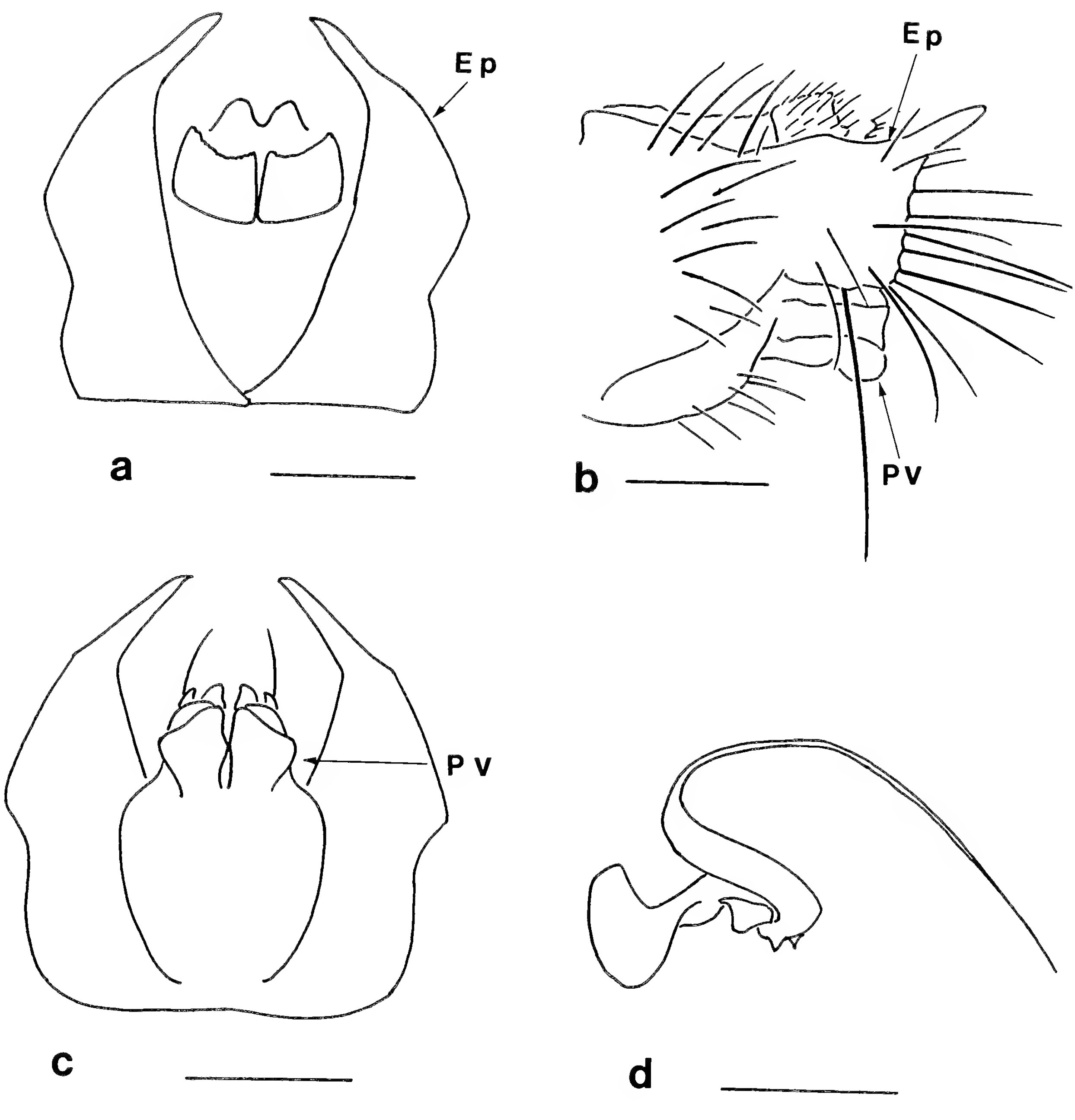

Figure 12. Male genitalia of *Beameromyia vulgaris* Martin; dorsal (a), lateral (b), and ventral (c) views; aedeagus (d). Scale = 0.3 mm.

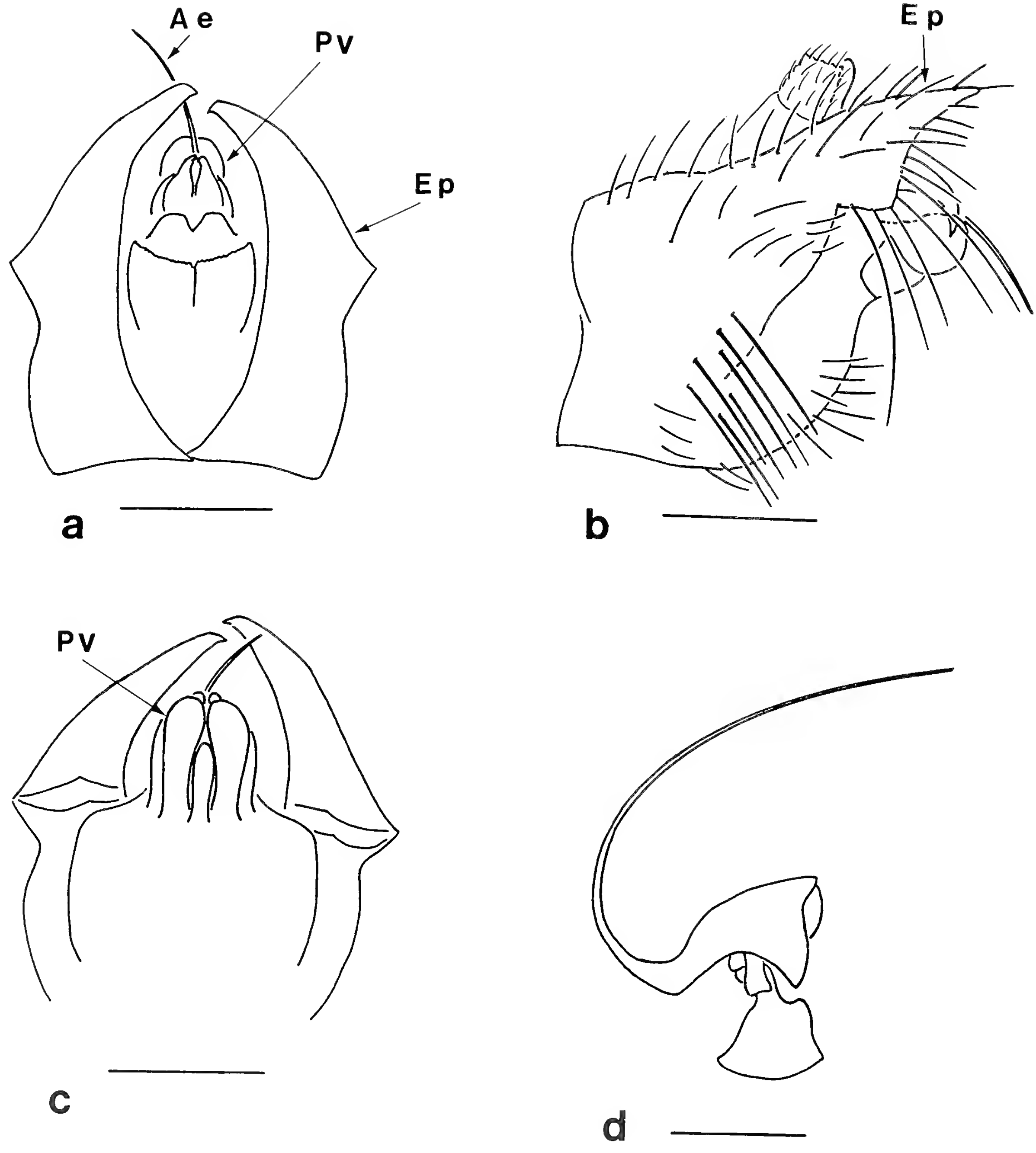

Figure 13. Male genitalia of *Beameromyia disfascia* Martin; dorsal (a), lateral (b), and lateral (c) views; aedeagus (d). Scale = 0.3 mm.

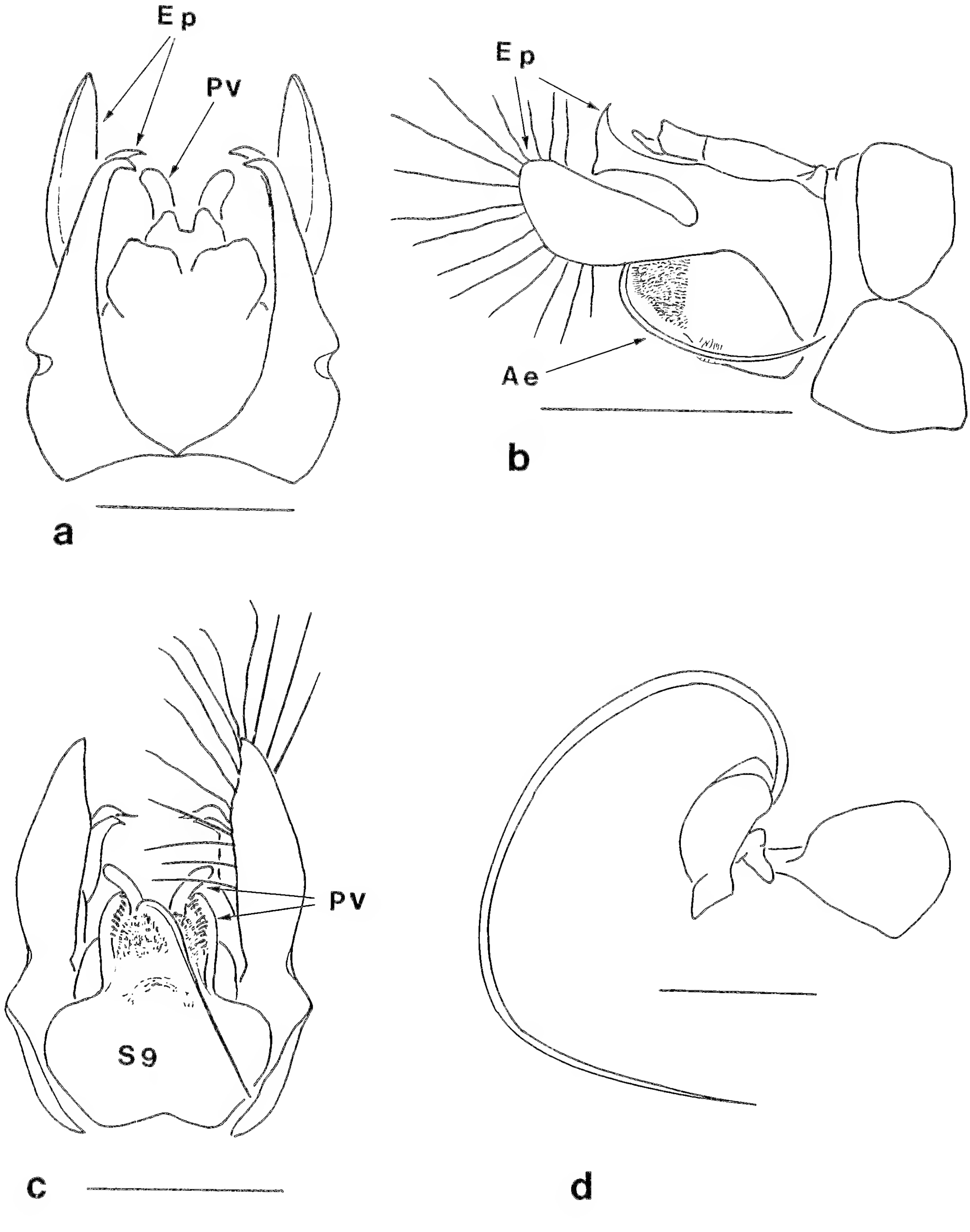

Figure 14. Male genitalia of *Leptogaster virgata* (Coq.); dorsal (a), lateral (b), and ventral (c) views; aedeagus (d). Scale = 0.5 mm.

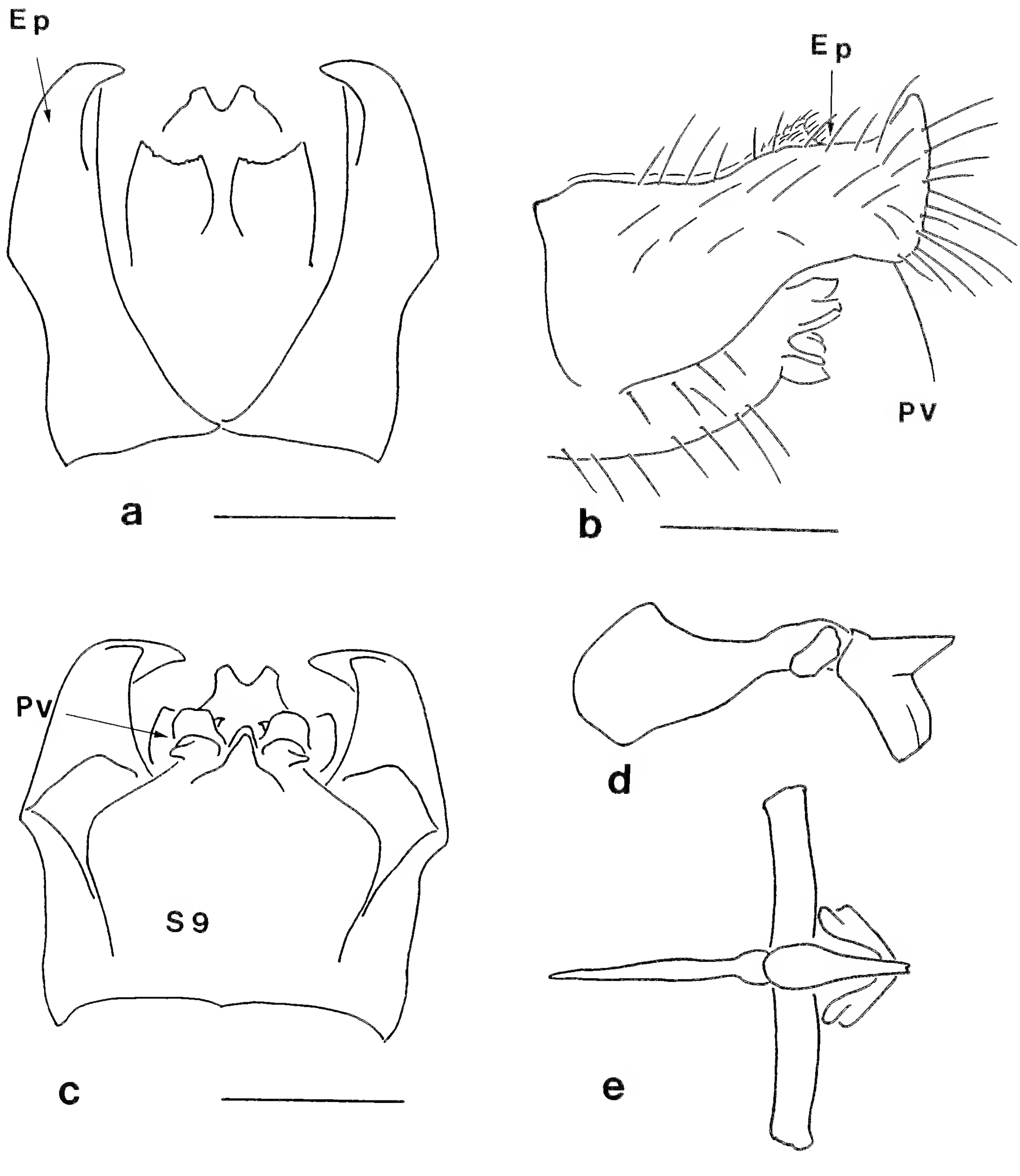

Figure 15. Male genitalia of *Leptogaster brevicornis* Loew; dorsal (a), lateral (b), and ventral (c) views; aedeagus, lateral (d) and dorsal views (e). Scale = 0.5 mm.

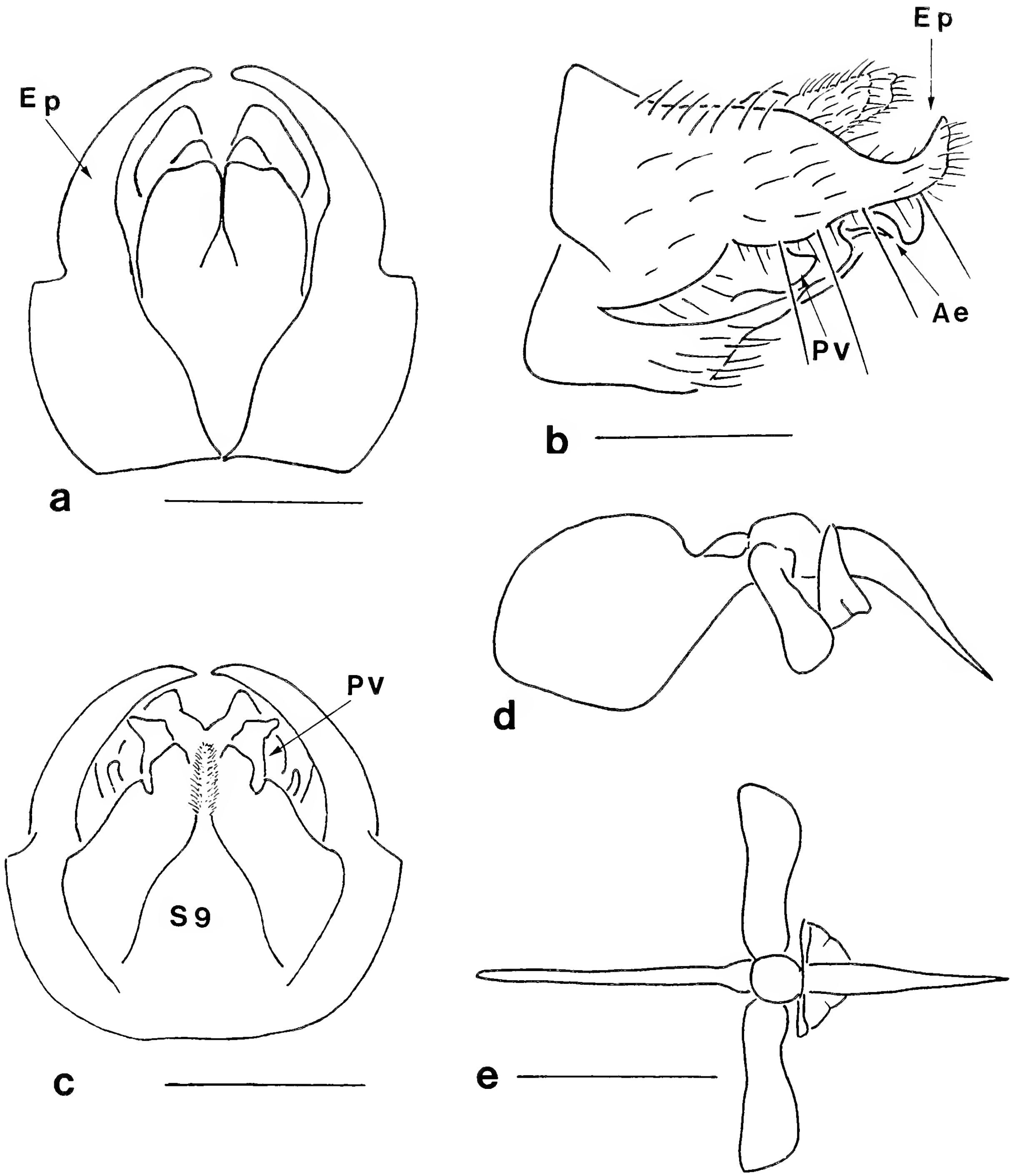

Figure 16. Male genitalia of *Leptogaster atridorsalis* Back; dorsal (a), lateral (b), and ventral (c) views; aedeagus, lateral (d) and dorsal views (e). Scale = 0.5 mm.

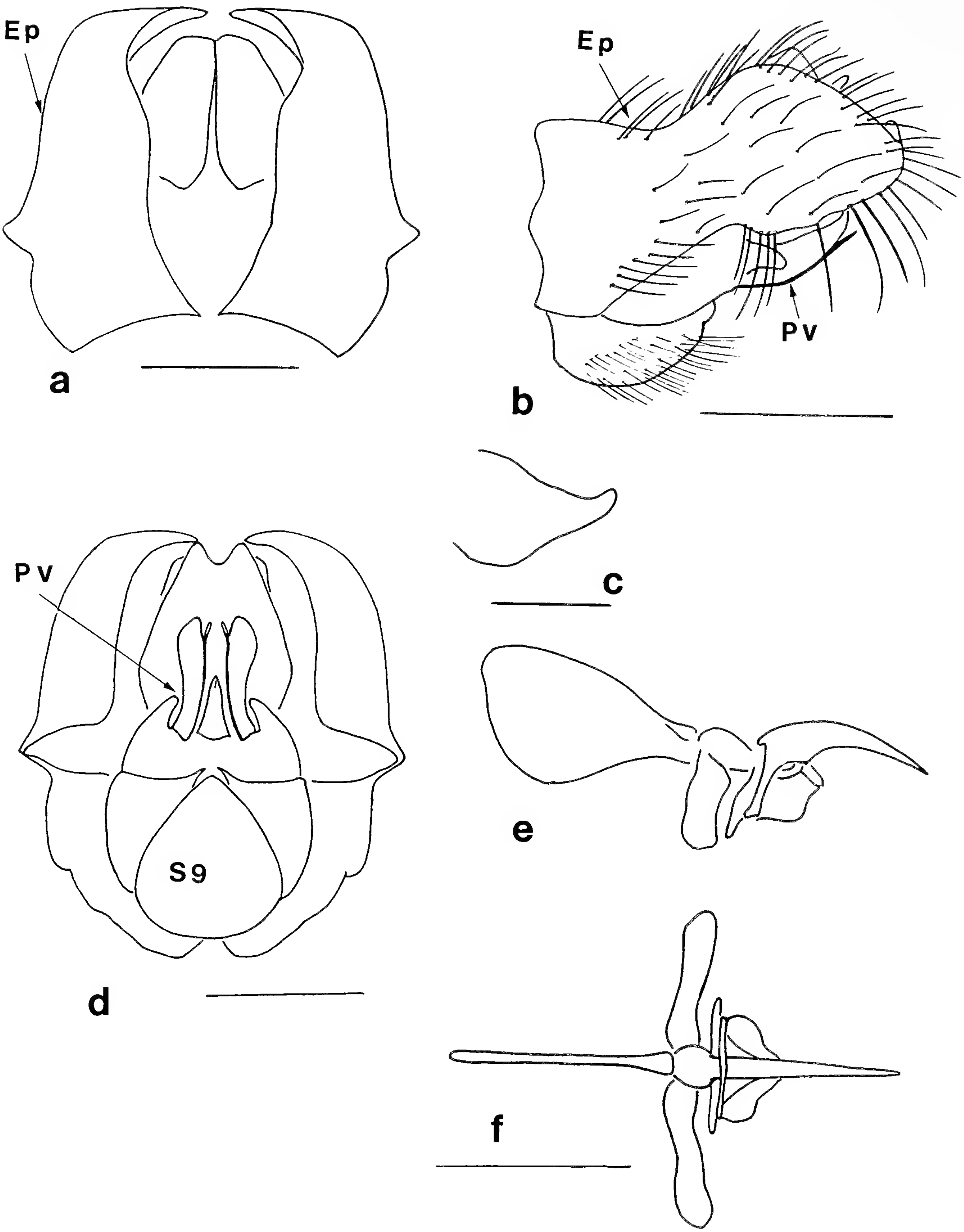

Figure 17. Male genitalia of *Leptogaster murina* Loew; dorsal (a), lateral (b), and ventral (c) views; apex of epandrium (d); aedeagus, lateral (e) and dorsal (f) views. Scale = 0.5 mm except d = 0.3 mm.

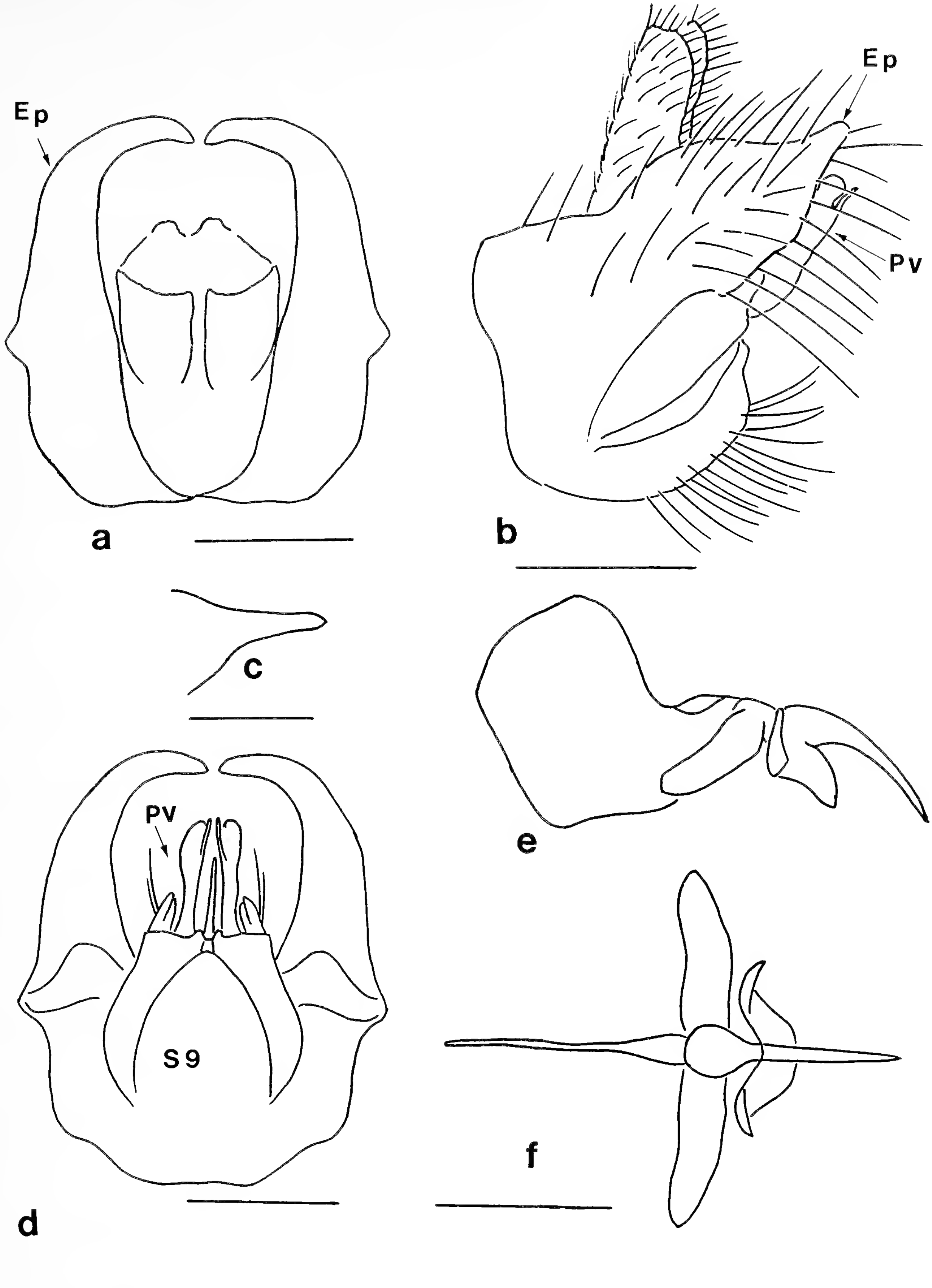

Figure 18. Male genitalia of *Leptogaster flavipes* Loew; dorsal (a), lateral (b), and ventral (c) views; apex of epandrium (d); aedeagus, lateral (e) and dorsal (f) views. Scale = 0.5 mm, except d = 0.3 mm.

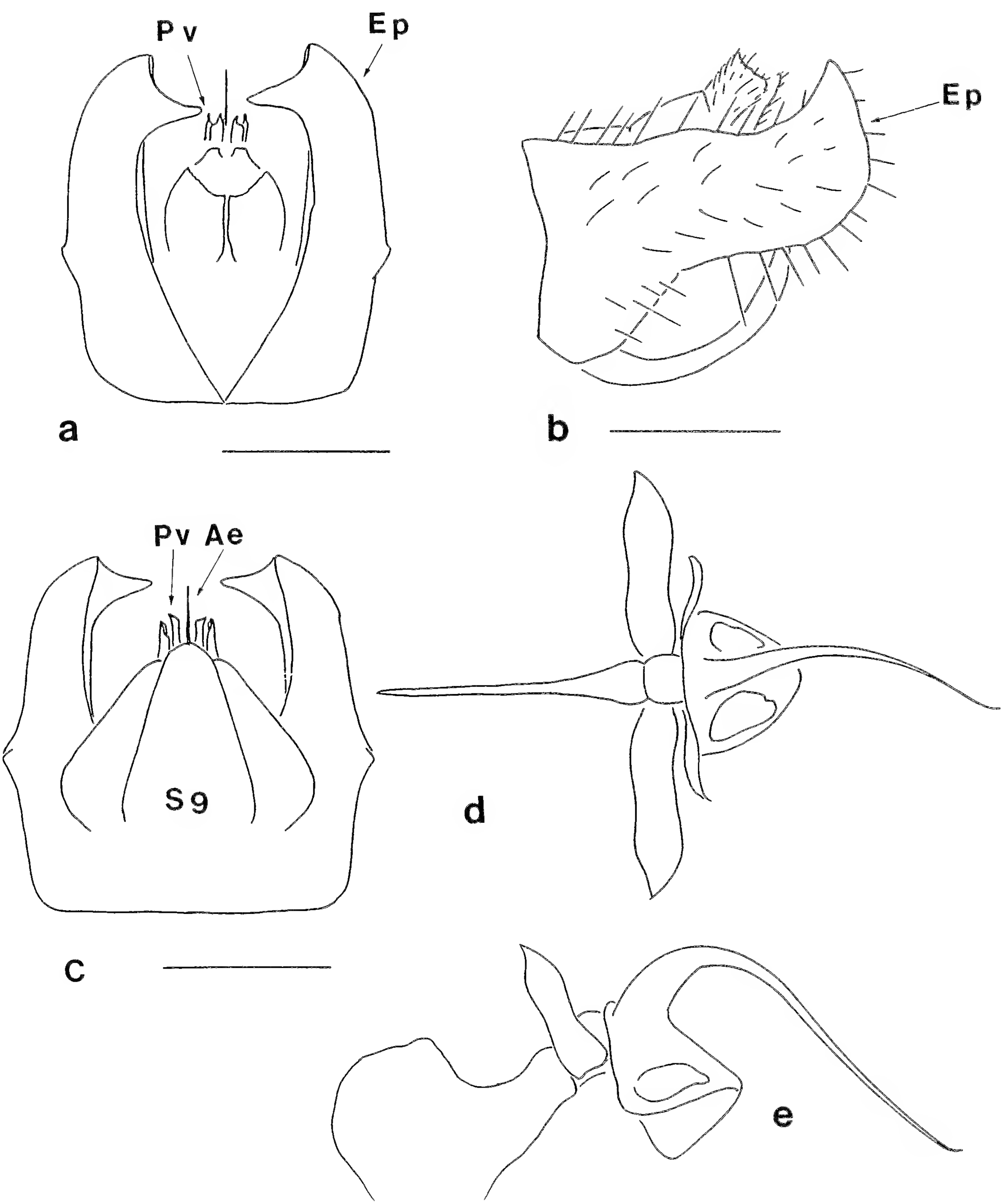

Figure 19. Male genitalia of *Leptogaster incisuralis* Loew; dorsal (a), lateral (b), and ventral (c) views; aedeagus, lateral (d) and dorsal (e) views. Scale = 0.5 mm.

Synopsis of Maryland and Delaware Species Records
Subfamily Leptogastrinae Schiner

Apachekolas tenuipes (Loew), 1862: 192. Type: MCZ, ♂; type locality ILLINOIS. MARYLAND: Baltimore Co., Montgomery Co.; 15 August-23 October. Specimens= 10 ♂♂, 16 ♀♀.

Beameromyia disfascia Martin, 1957: 357. Type: U.S.N.M., ♂, ♀; type locality NEW JERSEY. MARYLAND: Baltimore Co., Prince Georges Co., Montgomery Co.; 23 June-25 July. Specimens= 2 ♂♂, 1 ♀.

Beameromyia pictipes (Loew), 1862: 189. Type: MCZ ♂, ILLINOIS. MARYLAND: Anne Arundel Co.; 20 June. Specimens= 1 ♂, 1 ♀.

Beameromyia vulgaris Martin, 1957: 363. U.S.N.M. ♂, ♀; type locality WASHINGTON, D.C. MARYLAND: Baltimore Co., Prince Georges Co., Montgomery Co.; 19 June-2 September. Specimens= 2 ♂♂, 1 ♀.

Leptogaster atridorsalis Back, 1909: 59. Type: MCZ ♂, ♀; type locality PENNSYLVANIA. MARYLAND: Cecil Co., Montgomery Co., Prince Georges Co.; DELAWARE: Kent Co.; 14 July-23 August. Specimens= 4 ♂♂, 5 ♀♀.

Leptogaster brevicornis Loew, 1872: 62. Type: MCZ ♀; TEXAS. MARYLAND: Montgomery Co., Prince Georges Co., Washington Co.; 4 June-24 July. Specimens= 3 ♂♂, 5 ♀♀.

Leptogaster flavipes Loew, 1862: 193. Type: MCZ ♂, ♀; type locality NEBRASKA. MARYLAND: Baltimore Co., Cecil Co., Montgomery Co.; DELAWARE: Kent Co.; 28 May-6 September. Specimens= 92 ♂♂, 94 ♀♀.

Leptogaster incisuralis Loew, 1862: 190. Type: MCZ ♂, ♀; Eastern U. S. ?. MARYLAND: Montgomery Co., Prince Georges Co.; 21 June-11 August. Specimens= 6 ♂♂, 5 ♀♀.

Leptogaster murina Loew, 1862: 190. Type: MCZ ♀; type locality NEBRASKA. MARYLAND: Baltimore Co., Montgomery Co.; 7 May-16 July. Specimens= 4 ♂♂, 3 ♀♀.

Leptogaster virgata (Coquillett), 1904: 177. Type: U.S.N.M. 3♀♀; type locality TEXAS & WASHINGTON, D.C. MARYLAND: Montgomery Co., Prince Georges Co.; 12 June-8 August. Specimens= 6 ♂, 6 ♀♀.

Psilonyx annulatus (Say), 1823: 75. Type: lost; type locality PENNSYLVANIA. MARYLAND: Baltimore Co., Frederick Co., Howard Co., Montgomery Co., Wicomico Co.; 7 July-19 September. Specimens= 16 ♂♂, 75 ♀♀.

Tipulogaster glabrata (Wiedemann), 1828: 534. Type: MCZ ♂, ♀; type locality ILLINOIS. MARYLAND: Anne Arundel Co., Baltimore Co., Cecil Co., Calvert Co., Montgomery Co., Prince Georges Co.; DELAWARE: Kent Co.; 29 May-4 August. Specimens= 8 ♂♂, 17 ♀♀.

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The Rare Skipper in the Eastern Coastal U. S. and Maryland

Richard H. Smith, Jr.

Naturalists who carefully search buttonbush (*Cephalanthus occidentalis*) blooms at the Blackwater National Wildlife Refuge in Dorchester County, Maryland may spot a small yellow skipper butterfly that has been found at only a few other localities in the world. The butterfly is curiously named the rare skipper (*Problema bulenta* [Boisduval & LeConte]). The skippers, so-called because their flight motion often follows a skipping pattern, form the superfamily Hesperioidea of chiefly small to medium-sized butterflies with fat bodies and usually hook-tipped antennae. Although many skipper species are dark and drab, the rare skipper shows a uniformly pure yellow coloration on the underside of the wing when perching. On the upper side, the yellow is bordered and suffused with dark brown. Wingspan varies from 1.6 to 1.8 cm in males and 2.0 to 2.3 cm in females (Opler and Krizek 1984).

The word "rare" in the butterfly's common name is derived from the fact that for almost a century it had not been recollected and was known to most naturalists solely from a nineteenth century drawing. In fact, until the early 1960's the species was recorded from only two localities in its entire range along the eastern coast of the United States. The butterfly was first described by Boisduval and LeConte in 1833, based on a watercolor drawing sent to them by pioneering naturalist and artist John Abbot, after he observed the species in the northern coastal region of Georgia in the early 19th century. For most of the succeeding 100 years, *P. bulenta* was either uncollected or unrecognized, and gradually many lepidopterists came to regard Abbot's watercolor as a poor drawing of a more common, related species, the byssus skipper (*Problema byssus* [Edwards]). The declining interest in *P. bulenta* ended abruptly when eastern U.S. naturalist Dr. Frank Morton Jones rediscovered it along the Cape Fear River near Wilmington, North Carolina on July 28, 1925 (Harris 1972). For nearly 40 more years, this was the only site where this species was known to occur regularly, but in 1962, a new colony was located at the mouth of the Savanna River in South Carolina (J. Symmes in Mather 1963). Later that same year, another site was discovered slightly further south at Port Wentworth, Georgia, near the area where Abbot was believed to have originally observed this species (H. King in Mather 1963, Harris 1972). Additional colonies were discovered along the brackish reaches of the Chicahominy River in Virginia in 1967 (J. Bauer and B. Dixon in Covell and Straley 1973) and along the Santee River in South Carolina in 1975 (R. Gatrelle in Mather 1976). A Maryland river became the fifth major site for *P. bulenta* when coleoptera expert Dr. John Glaser found it on July 23, 1979 in the Blackwater River area of Dorchester County (Simmons and Andersen 1978, Winter 1980). Subsequent surveys in this area by the author and other lepidopterists have shown that well over 100 individuals can be observed at certain locations during the flight season. Careful surveys of similar habitats have recently turned up additional colonies of *P. bulenta* in southern New Jersey in 1989 (Schweitzer in Winter 1990), and near Bombay Hook National Wildlife Refuge in Delaware in 1992 (by the author).

Problema bulenta is apparently single-brooded in Maryland with a flight period extending from late June through July. In addition to buttonbush, the butterfly has been observed nectaring on indian hemp (*Apocynum cannabinum*), red clover (*Trifolium pratense*), common milkweed (*Asclepias syriaca*), purple milkweed (*Asclepias purpurascens*), and swamp milkweed (*Asclepias

incarnata) (Krizek and Opler 1986, also author's field notes). Documenting the early stages in the life history of this species has not been easy due to extreme difficulty in tracking the rapidly flying females to oviposition sites in the surrounding brackish marsh habitat. Although marsh millet (*Zizaniopsis miliacea*) has been linked to the rare skipper as a potential larval food plant because of the similarity of its distribution and that of the butterfly in the southeastern United States (Opler and Krizek 1984), larval observations or rearings on this plant have never been reported and *Z. miliacea* does not seem to be present at the Maryland site. Very recently, however, Drs. William Cromartie and Dale Schweitzer found skipper larvae on salt reed grass (*Spartina cynosuroides*) growing at a *P. bulenta* site in New Jersey. They reared an adult that emerged as none other that *P. bulenta* (Cromartie and Schweitzer, in press).

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Notes on the Occurrence of the Freshwater Jellyfish,
***Craspedacusta sowerbi*,**
in Anne Arundel County, Maryland

James G. Turek

The freshwater jellyfish, *Craspedacusta sowerbi*, has been found in nearly all states since it was first documented in the United States in 1908 (Pennak 1978). The species has occasionally been observed in Maryland waters. Allan (1952) first recorded the presence of *C. sowerbi* in Maryland in the Potomac River at Plummers Island. More recent sightings have been recorded in ponds in Montgomery and Washington Counties (Rivers 1978), and Dorchester County (Grogan 1989). These observations have all been of free swimming medusae found in near surface waters, typically between July and October. The asexual, branching colonial hydroids are usually less than 0.2 mm long and attach to hydrophytes and other suitable substrates, making visual observations difficult until they transform into swimming adults. The presence of the medusae is often sporadic, and they may be abundant one year but absent from the same locale in subsequent years.

On August 12, 1992, a colleague and I observed medusae of *C. sowerbi* in an impoundment in the Swan Creek drainage of northern Anne Arundel County. The 11.5 acre Coastal Plain lake was created by impounding of waters behind an old B&O railroad berm which transects the drainage. The lake has a maximum depth of eight feet. Water willow (*Decodon verticillatus*) dominates the nearshore areas and muskgrass (*Chara* sp.), a submerged aquatic plant is abundant throughout the lake. Mixed upland forest characterizes much of the surrounding area. Surface drainage into the lake flows through forested and scrub-shrub wetlands. Lake waters are stained but clear, with visibility depths of more than two feet noted.

Surveying much of the lake by canoe during midday, we found medusae to be abundant in the near surface waters. However, they were not evenly distributed throughout the lake. The heaviest jellyfish densities were observed in the eastern section, probably due to light westerly winds that were present during our visit. All medusae were of approximately the same size. The diameter of the medusal bell ranged between 10 and 15 mm, while each individual had four long, outreaching tentacles ranging from 8 to 15 mm in length. Many shorter tentacles formed the fringe of the bell. As we noted their swimming habits, the jellyfish pumped upward or sideways with the long tentacles extended. Once contractions ceased, the medusae slowly sank, remaining motionless until the pumping contractions began once again.

Prior to this sighting, I had read of freshwater jellyfish but knew little of their habits, habitat, or geographical distribution. After discussing our observations with several colleagues, we decided to revisit the pond in an attempt to make additional investigations. We were not able to return to the pond until late afternoon on October 1st, and expected that the medusae would be absent because of several days of cold weather. Surprisingly, the jellyfish were still abundant, in numbers similar to those noted during our visit earlier in the season. The jellyfish were again most common in the eastern section of the lake, where we estimated densities of 8 to 50 medusae per cubic foot of near surface water. With little daylight left, we were unable to estimate numbers in the lower depths. Since numerous jellyfish were present near the surface during the

waning daylight hours, we concluded that these organisms may not be strongly positively phototropic and that the numbers of jellyfish in the lower depths of the pond may have been similar to those found near the surface.

The number of jellyfish in this small coastal lake was astounding. Assuming a conservatively estimated average of 20 individuals per cubic foot of near surface water, more that 10 million jellyfish may have been present in the upper levels alone! It would be interesting to discover what niche this unpredictably appearing organism occupies, and how it's predatory role affects zooplankton in our freshwaters.

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The following individuals kindly reviewed manuscripts for Volume 36 of *The Maryland Naturalist* at the request of the editor. Their assistance is gratefully acknowledged.

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Proceedings of the Natural History Society of Maryland

The Natural History Society of Maryland began publishing educational natural history material almost as soon as it was established in 1929. In addition to this journal, a series of other papers has appeared sporadically as the *Proceedings of the Natural History Society of Maryland.* The first of these appeared in 1930 and the last was published in 1949. They were produced in-house and were typically mimeographed with professionally done photographic plates. The following list includes all titles published in that series.

The NHSM plans to revive the *Proceedings* to make possible the publication of papers that are too large to fit into *The Maryland Naturalist.* At present, two manuscripts are undergoing review. The appearance of future numbers will be noted in the newsletter. Information on the availability and cost of back issues can be obtained from the secretary, at the address given inside the back cover.

Number 1. Stansbury Haden. 1930. Some Notes on the Color Variation of Lepidoptera with Reference to Climatic and Weather Conditions. 5 pages.

Number 2. Stansbury Haden. 1931. *Dynastes hercules* and *Dynastes titryus*: A Brief Comparison Between Two Beetles of the Family Scarabaedae, one Native to Maryland and the other of the South American Fauna. 4 pages, 1 plate.

Number 3. Stansbury Haden. 1933. The Papilionidae of Maryland. 14 pages.

Number 4. Stansbury Haden. 1934. The Satyridae of Maryland. 10 pages.

Number 5. Bryant Mather Jr. 1937. A Report on the Geology of the Patapsco State Park of Maryland. 36 pages, 1 map.

Number 6. Richard E. Stearns. 1941. The Hughes Site- An Aboriginal Village Site on the Potomac River in Montgomery County, Maryland. 15 pages, 5 plates.

Number 7. Romeo Mansueti. 1941. A Descriptive Catalogue of the Amphibians and Reptiles Found in and around Baltimore City, Maryland, within a Radius of Twenty Miles. 53 pages, 2 plates.

Number 8. William H. McClellan, Romeo Mansueti and Francis Groves. 1943. The Lizards of Southern Maryland. 42 pages, 9 plates.

Number 9. Richard E. Stearns. 1943. Some Indian Village Sites in Tidewater Maryland. 31 pages, 18 plates.

Number 10. Richard E. Stearns. 1949. Some Indian Village Sites of the Lower Patapsco River. 6 pages, 5 plates, 1 map.

The Maryland Naturalist is a quarterly publication of the Natural History Society of Maryland. Subject matter includes all areas of the natural history of Maryland and adjacent states. Suitability of manuscripts will be determined by the editor. Accepted manuscripts will be reviewed by appropriate specialists prior to publication. Address all manuscripts and correspondence to Editor, *The Maryland Naturalist*, Natural History Society of Maryland, 2643 North Charles Street, Baltimore, Maryland 21218.

When possible, manuscripts should be submitted on IBM compatible 5¼ inch high density floppy discs formatted for Word Perfect 5.0, 5.1 or other compatible software (this is particularly important with longer manuscripts). If word processing capability is not available, submit manuscripts typed, double spaced, on good quality bond paper with adequate margins. Authors should adhere generally to the *Council of Biology Editors Style Manual*. However, individuality and readability of writing style are encouraged.

Contributions other than short notes may include a brief informative abstract. Payment of page charges is not required for publication in *The Maryland Naturalist*. However, if funds are available, assistance to offset publication costs would be welcome.

Subscription to *The Maryland Naturalist* comes with membership in the Natural History Society of Maryland. Information on the availability and cost of back issues will be provided on request.

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